

ESSAYS ON ACCOUNTING ISSUES RELATED TO TECHNOLOGY TRANSACTIONS

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To my beloved late grandpa for his love, support, and belief in me.

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ABSTRACT

ESSAYS ON ACCOUNTING ISSUES RELATED TO TECHNOLOGY TRANSACTIONS

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This thesis investigates accounting issues related to intangibles in inter-firm contracting and information-sharing settings. In contracting over intellectual properties (e.g., patents), accounting-based payments are commonly used to mitigate valuation and incentive problems (Kamien, 1992), and in turn, create misreporting problems between contracting parties. In the first essay, I investigate how such misreporting risk affects the design of contract audit terms. In the second essay, co-authored with Jennifer Blouin, I use technology licensing agreements as a setting to document the presence of implicit taxes in large-sample inter-firm contracts. In the third essay, co-authored with Brian Bushee and Thomas Keusch, I focus on information sharing among competitors in the technology sector and potential proprietary benefits of voluntary disclosure. In particular, we investigate the implication of “co-opetition” (i.e., cooperation among competitors) on managers’ ability to predict future performance.

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PREFACE

This thesis investigates accounting issues related to intangibles in inter-firm contracting and information-sharing settings. In contracting over intellectual properties (e.g., patents), accounting-based payments are commonly used due to valuation and incentive problems associated with intangibles (Kamien, 1992). The prevalence of accounting-based payments creates misreporting problems between contracting parties. In the first essay, I investigate how such misreporting risk affects the design of contract audit terms. Using a novel, hand-collected dataset, I show that perceived weaknesses in the licensee's reporting system lead to the granting of broader audit rights to the licensor, consistent with licensors demanding broader auditor rights when the licensee's accounting system is believed to be less reliable. However, when the licensee has greater reporting flexibility, the contracting parties are more likely to include penalties in their agreements, consistent with the deterrence theory that penalties are a more cost-effective means to discourage intentional misreporting. Overall, my results suggest that audit scope and penalties can improve contracting efficiency in two different ways.

In the second essay, co-authored with Jennifer Blouin, I use technology licensing agreements as a setting to study implicit taxes. This is one of the first studies to attempt to document the presence of implicit taxes in large-sample inter-firm contracts. Technology transactions provide a good setting because the royalty terms (i.e., percentage of sales) allow us to compare pricing across contracts and to directly observe the effects of bargaining power on contractual terms. We rely on implicit tax theory and predict that higher royalty rates are charged to licensees when licensor firms face higher tax rates on their income from technology transfers. In preliminary analyses, we find a positive association between royalty rates and state-level corporate taxes faced by the

licensor. This finding suggests that licensors consider their tax burden when setting royalty rates, and their tax burden, in turn, may be passed onto their customers.

In the third essay, co-authored with Brian Bushee and Thomas Keusch, I study information sharing among competitors in the technology sector. In particular, we investigate the implication of “co-opetition” (i.e., cooperation among competitors) on managers’ ability to predict future performance. Using a novel dataset on firm participation in Standards Setting Organizations (SSOs), we test whether firms potentially receive an unintended benefit from access to competitor and industry information. Comparing firms that actively contribute information in SSOs with firms that passively participate (i.e., do not share information), we find that SSO-contributing firms are more likely to issue annual sales forecasts after initiating their collaboration. We also find the SSO-contributing firms experience an improvement in the accuracy of their annual sales and earnings forecasts and a reduction in the dispersion of analysts’ earnings forecasts. Our findings contribute to the literature by showing that collaborating with competitors in the product market provides an important unintended benefit of improving the manager’s information set.

My studies of accounting issues related to technology transactions shed a new light on information problems faced by firms in the technology sector. Price protection is not a viable option of mitigating misreporting risk in technology transactions because future values generated by technology (i.e., amounts owed to licensors) are highly uncertain *ex ante*. Thus, audit terms, as opposed to price protection, play a critical role in mitigating misreporting risk. In addition, given product market benefits of technology compatibility, firms may additionally face proprietary *benefits* of voluntary disclosures to competitors in the technology sector. Collectively, these findings deepen our knowledge of technology firms’ distinct information environments, especially in inter-firm contracting and information-sharing settings.

CHAPTER 1. External Verifiability of Accounting Information and Intangible Asset Transactions

1.1. Introduction

Accounting-based payments are commonly used in contracts, such as cost-plus supply contracts or intangible transactions, where future contingencies are difficult to codify. In these contracts, verifiability of accounting information is critical in facilitating efficient contracting and protecting the less informed party. Among different contract types with accounting-based payments, technology licensing agreements (TLA) predominantly contain accounting-based royalties; approximately 90% of TLAs are royalty-based (Bessy et al. 2002). In TLA, the licensor (i.e., the owner of intellectual property (IP) assets) grants the licensee the right to incorporate its IP into products or services, typically in exchange for royalties. Accounting-based royalties mitigate many of contractual hazards, such as adverse selection, moral hazard, and inefficient risk sharing between the contracting parties (e.g., Stiglitz 1974; Allen and Lueck 1993; Bhattacharyya and Lafontaine 1995). However, these royalty terms rely on disaggregated accounting information (e.g., product-level sales) and induce the risk of misreporting between the contracting parties. In particular, the licensor is exposed to weaknesses in its licensee's reporting process, as well as the risk of opportunistic reporting. As a result, the licensor needs a means to verify the contracted accounting proxies—an aspect largely overlooked in the economics literature.¹

This paper addresses this gap by examining the contractual audit terms included in a hand-collected sample of technology licensing agreements that base royalties on

¹ The economics literature assumes that the royalty holder costlessly observes (verifies) disaggregated accounting information (e.g., product-level sales) (Gallini and Wright 1990; Beggs 1992; Bousquet, Cremer, Ivaldi, and Wolkowicz 1998; among others).

product-line revenues. TLAs are a useful setting to examine how the licensor's misreporting risk affects the design of the contractual audit terms for several reasons. First, these agreements are economically significant; the worldwide incomes from TLAs are US\$310 billion in 2013 alone, and their growth has outpaced the growth of worldwide GDP (World Trade Organization 2014). Second, contracting parties bilaterally negotiate and voluntarily incorporate audit terms in these contracts, leading to wide variations across contracts. Third, and most importantly, contractual audit terms are ubiquitous elements of these contracts. Financial audits do not eliminate the need for contractual audits because royalty reports require a level of detailed information that is much finer than that included in the audited financial statements. However, there is limited research on the characteristics of contractual audit terms, which are necessary enforcement clauses for these accounting-based royalties. This study contributes to our understanding of how contractual audit terms are used to mitigate misreporting problems not only in TLAs, but also in other contracts that rely on disaggregated accounting information.

I investigate two main dimensions of contractual audit terms in TLAs: (1) the scope of the licensor's audit rights, and (2) the penalties for negative audit results. First, the audit clauses can limit the scope of the royalty audit to certain prior periods (i.e., how far back the licensor may audit) and/or restrict the number of audits performed on the licensee. Second, the licensor may penalize the licensee by shifting the burden of audit fees to the licensee upon detecting a substantial error, and/or imposing interest penalties on underpaid prior royalties. In addition to these explicit penalty terms, an implicit penalty is early termination of the contract following a material breach, including willful underreporting. These explicit and implicit penalties can have deterrence effects by making misreporting more costly to the licensee.

To motivate the empirical analyses, I rely on the prior research on financial audits, law enforcement, and contract economics. I first investigate how *ex ante* signals regarding the strength and reliability of the licensee's accounting system affect the audit terms. Although weaknesses in the licensee's accounting system can have direct impact on royalty reporting errors (Throckmorton 2008), the licensor typically has limited information about the licensee's overall reporting system at the time of contracting. Given this limited information, the licensor may instead rely on the licensee's financial auditor characteristics as signals of accounting system weaknesses.² When the licensee employs a lower-quality auditor (e.g., non-Big N or industry non-specialist auditor), the licensor will infer a higher chance of reporting weaknesses and find broader audit rights more valuable. However, while broader audit rights are useful in detecting both intentional and unintentional misreporting due to reporting weaknesses, penalties work as an effective deterrent only for *intentional* misbehaviors (e.g., Becker 1968). To the extent the licensor expects a higher chance of unintentional errors from the licensee with a lower-quality auditor, imposing explicit penalties on such a licensee leads to higher expected penalties—even in the absence of any intentional misreporting—without necessarily achieving greater deterrence effects. Thus, I predict that contracts are more (less) likely to include broader audit rights (penalties) when the licensee is perceived to have a weaker reporting system.

Second, I consider how the licensee's reporting flexibility shapes the audit terms. The licensee has greater reporting flexibility (i.e., discretion to report royalties opportunistically) when more deductible items are included in the royalty base. The royalty base can range from *gross* revenues to contractually-defined *net* revenues, where allowed deductibles (e.g., returns, discounts and transportation costs) are subtracted from gross

² This argument is based on discussions with royalty auditors, as well as research on the use of auditor quality as a signal of accounting system quality (e.g., Krishnan 2003; Khurana and Rama 2004; Mansi et al. 2004).

revenues. Royalty auditors suggest that these deductions are frequent sources of intentional misreporting due to issues such as unfair allocation of costs relative to underlying economic activities, licensee-favorable interpretations on various deductibles, and failure to incorporate agreement-based limitations to deductions (Stewart et al. 2017; Ruey 2013; Nolte 2017). To the extent that greater licensee reporting flexibility increases the licensor's concern for *intentional* misreporting, the licensor will prefer penalties to broader audit scope terms because penalties are more cost-effective in deterring intentional misbehaviors (Becker 1968). The licensee with greater reporting flexibility will also prefer penalties to broader audit rights because the potential for more extensive, frequent audits increases the cost of preparing for and hosting royalty audits. Thus, I predict that contracts are less (more) likely to include broader audit rights (penalties) when the licensee has greater reporting flexibility.

Lastly, contract theory suggests that the implicit cost of termination can increase the licensee's incentive to self-enforce accurate royalty reporting, leading to a lower need for auditing. The licensee is incentivized to self-enforce the contractual terms when its opportunity cost of contract termination (i.e., a stream of future foregone rents) increases (Klein and Leffler, 1981; Williamson, 1985; Klein and Murphy, 1988; among others). Theory predicts that the licensor can reduce its auditing intensity when the contract includes specifications that induce self-enforcement, such as features that guarantee future expansion opportunities and exclusive market positions (Klein 1980 & 1995; Lafontaine and Raynaud 2002). Accordingly, I expect that contractual features such as (i) a worldwide license, (ii) a long-term license (i.e., features that provide expansion opportunities), and (iii) an exclusive license (i.e., a feature that ensure exclusive market positions) reduce the need for broader audit rights.

Consistent with my predictions, I find that licensees with low-quality auditors are associated with broader audit rights, consistent with licensors perceiving firms with low-quality auditors to have less reliable accounting systems. In contrast, I find evidence that penalty terms are less likely to be imposed on licensees whose reporting systems are expected to produce more unintentional errors. In addition, I show that when the licensee has high reporting flexibility, penalties are more likely to be used as a deterrent, while broad scope audit rights are less likely to be employed. These findings are consistent with the deterrence role of penalties being more cost effective for intentional misreporting. Finally, the evidence suggests that licenses covering more territory and having longer durations lead to less stringent audit terms, consistent with the self-enforcement theory that the greater expansion opportunities increase the licensee's incentive to self-enforce, and thus reduce the licensor's need for audits. I further find that these results are not driven by the licensors price-protecting themselves against the misreporting risk via higher royalty rates. Overall, my findings suggest that audit scope and penalties can improve contracting efficiency differentially, depending upon the contractual parties' concerns regarding unintentional and intentional misreporting.

My paper makes two main contributions. First, the evidence in this study, combined with prior evidence on the prevalence of accounting-based royalties (e.g., Bessy et al., 2002), suggests that firms can mitigate the contracting problems associated with intangibles (e.g., intellectual properties) by relying on disaggregated accounting measures and designing audit terms to verify the contractible proxies. These findings support the view of Christensen and Demski (2003), who argue that external verifiability by third parties is the comparative advantage of accounting information relative to other information sources. This paper also complements a recent study by Lisowsky and Minnis (2017), which shows that verified and standardized accounting information can be more

important for firms with high intangible assets than those with high physical assets. My results suggest that the reliability of accounting reporting systems becomes important for intangible-intensive firms in facilitating intangible asset transactions.

Second, I contribute to the literature investigating various accounting-based means for mitigating information asymmetries in contractual relationships. A growing literature examines information asymmetry problems in supply contracts. For example, Costello (2013) finds that the use of financial covenants and contract duration can mitigate the information asymmetry problems in supply contracts, while Samuels (2017) suggests that customer monitoring of supplier financial systems can improve the supplier's internal information environment. In addition, there is an extensive literature in debt contracting that investigates how accounting-based covenants can be used to mitigate information asymmetries in these contracts.³ My paper adds to this literature by showing that contractual audit rights and penalties can also be used to mitigate accounting-related information asymmetry problems.

The remainder of the paper proceeds as follows. Section 2 provides background information on technology licensing agreements and develops my empirical predictions. Section 3 discusses the data, the main variables, and the descriptive statistics. Section 4 presents the research design. In Section 5, I discuss the main results. Section 6 discusses potential threats to the paper's inferences and robustness tests. Section 7 concludes the paper.

³ See Barclay and Smith (1995), Sufi (2007), Frankel and Litov (2007), Ball, Bushman, and Vasvari (2008), Bharath, Sunder, and Sunder (2011), Nikolaev (2010), Costello and Wittenberg-Moerman (2011), Demerjian (2007), and Demerjian (2011), among others.

1.2. Background

1.2.1. *Technology Licensing in Incomplete Contracting Framework*

Many theory papers model technology licensing contracts in an incomplete contracting framework, where the basic premise of the model is the incompleteness of licensing agreements (see Macho-Stadler and Perez-Castrillo, 1991; Beggs, 1992; Gallini and Weight, 1990; Choi, 2001; Podder and Sinha, 2002; among others). Technology licensing is incomplete for many reasons. First, the technology to be transferred cannot be specified exactly in the contract and contains tacit components that are difficult to be codified. Second, the process of technology transfer is not observable and therefore is susceptible to the moral hazard problem (Jensen and Meckling, 1976; Caves et al., 1983). Also, efforts made by the licensee are not contractible. Finally, the future trajectory of the licensed technology is difficult to predict and to be verified by a third party. Thus, the contracting parties cannot specify all possible contingencies. Given the nature of technology licensing, royalty terms can mitigate contractual incompleteness because they depend on verifiable quantity or sales *ex post*, and specify the future allocation of property rights between the licensor and licensee. The incomplete contract approach therefore provides a well-supported explanation for why, in practice, licensing contracts are predominantly royalty-based.

1.2.2. *Why license?*

A potential licensor (i.e., the owner of proprietary technology) may license its intellectual properties (IP) instead of exploiting them on its own for a variety of reasons. First, the licensor may save costs when an external party (e.g., the potential licensee) has lower costs of exploiting the IP than the licensor, which creates potential gains for entering into a licensing contract. Second, the licensor and licensee may have different competitive advantages. The licensor may specialize in conducting R&D activities and building core

technology while the potential licensee may have competitive advantages in producing, marketing, and distributing final products. Third, the licensor may benefit by accessing the licensee's resources, such as existing facilities, global distribution network, and expertise in the regulatory process (e.g., FDA compliance), which can improve time-to-market for new products and lead to faster market penetration. This benefit is especially important when timing is critical, the pace of innovation is accelerating, or the nature of future competition and markets is difficult to determine (Teece and Pisano, 1994).

However, licensing is not without costs. In choosing to license its technology, the firm incurs monitoring costs because the firm essentially delegates responsibility to its licensee (i.e., the agent) for bringing products to the market. Licensing also exposes the licensor to adverse selection risk because the licensor is asymmetrically informed about the licensee's quality (e.g., the quality of the licensee's capabilities and resources). In addition, the licensor may be concerned about expropriation risk to the extent that the licensee may become a potential competitor upon learning the licensor's proprietary technology. In circumstances where the costs of licensing do not justify licensing transactions, the firm will choose to incorporate its proprietary technology into its own production, rather than licensing it out.

1.2.3. Fixed fee versus royalties licensing

A vast theoretical literature has examined the optimal payment scheme when a firm does decide to license its technology. The results of these theoretical studies are mixed regarding the superiority of fixed fee licensing versus royalty licensing. One stream of research argues for the superiority of fixed fee licensing (e.g., Kamien and Tauman 1986; Kamien 1992; Kamien, Oren, and Tauman 1992; among others). In a complete information framework where there is no adverse selection problem, a fixed fee (i.e. high fee for the high demand and low fee or the low demand) is optimal for the contracting

parties. In addition, some studies assume that royalties to be unenforceable due to information asymmetry and focus on the superiority of the fixed fee mechanism (e.g., Katz and Shapiro 1986). Another stream of studies argues for the superiority of royalty licensing. In an incomplete information framework, where the licensor has private information about the actual value of the patent, the licensor offers royalty contracts to signal the high quality of its patent to the potential licensee who is asymmetrically informed. Royalty licensing acts as a signaling device to the potential licensee and is shown to induce a more efficient outcome than fixed-fee licensing (e.g., Beggs, 1992; Gallini and Wright, 1990; among others). In addition, Autrey and Sansing (2014) suggest that the superiority of fixed fee versus royalty licensing depends on the licensees' accounting system. In particular, their theoretical model shows that the strength of the licensee's accounting system increases the desirability of royalty licensing over fixed fee licensing.

Despite the mixed theoretical predictions on the optimality of fixed fee versus royalty licensing, empirical evidence suggests that royalty licensing is most commonly employed in practice.⁴ Surveys indicate that between 85% to 92% of licensing agreements include royalty terms.⁵ This prevalence of royalty licensing is likely driven by royalties alleviating a licensee's fear of overpaying for a license and a licensor's fear of undercharging when there is great uncertainty over the future value of the licensed technology (Kamien, 1992).

⁴ E.g., Taylor and Silberston 1973; Caves, Crookell, and Killing 2009; Rostoker 1983; Macho-Stadler, Martinez-Giralt, and David Pérez-Castrillo 1996; Thursby, Jensen, and Thursby 2001; and Bessy and Brousseau 1998

⁵ For instance, Bessy, Brousseau and Saussier (2002) report that 92.4% of sample technology licensing agreements include royalties. Rostoker (1983), using a firms survey, reports royalty-based licensing accounts for 85 percent of the licensing arrangements. Other studies including Contractor (1981), Taylor and Sylberston (1973), and Bessy and Brousseau (1998) document that royalties are the predominant form of payments in TLAs.

1.2.4. Institutional background on royalty audits

License agreements typically require the licensees to periodically report disaggregated accounting information such as product-level sales, deductions, and sales by territory (Blum 2015). Licensors cannot directly observe this specific accounting information without royalty audits that are specified in the licensing agreements.⁶ A licensor contemplating initiating a contract audit trades off the expected benefits of reduced information asymmetry with the audit costs. The main two benefits of the audit include: (1) detecting and recovering underpayments, and (2) deterring future misreporting by signaling monitoring efforts. In practice, a royalty audit is a complex, difficult, and expensive process (Keller et al., 2003). The licensor is responsible for paying the audit fees, unless the contract specifies otherwise. In addition to the monetary cost of royalty audits, the licensor may also have to bear a non-monetary cost to the extent that the licensee interprets extensive, frequent audits as a sign of mistrust, which potentially limits their future business opportunities.⁷ A rational licensor therefore attempts to maximize royalty revenues net of audit costs. To the extent that the expected benefit from an audit (e.g., the expected magnitude of underpayments that will be recouped) does not exceed the audit cost for a given period, the licensor may forego recovering underpaid royalties and choose not to undertake a royalty audit on the given period, even if it is allowed in the

⁶ A more convenient method of determining royalty payments is to base the royalties on the licensee's *firm-level* sales, as opposed to the disaggregated (e.g., product-level) sales. To the extent that the firm-level sales information is publicly available in the licensee's audited financial statements, this method can eliminate the need for costly royalty audits. However, royalties on *firm-level* sales are rarely used because they give rise to regulatory concerns (Verbraeken, 2011). Given that the total sales comprise both products that incorporate and do not incorporate the licensed technology, royalties on firm-level sales allow the licensor to extract rents from the licensee that go beyond the scope of the licensed patent(s). This aspect gives rise to patent misuse and antitrust interrogations by the regulatory agencies such as the DOJ.

⁷ An article by royalty auditors suggests that some licensors are hesitant to undertake audits because they are afraid of signaling mistrust to their licensees (Stewart et al 2007).

contract. For this reason, most licensors do not commit to regularly auditing their licensees in practice.⁸

Once a licensor decides to initiate a royalty audit, the licensee's relevant books of account may be audited according to the contractual audit terms, which are specified in the contract. Because licensees' detailed accounting information is confidential, the licensor is typically required to hire a contract compliance or royalty auditor to delegate the audit work. Royalty audit services can be purchased from audit firms or law firms that provide contract compliance and audit services. If royalties have been intentionally underreported, the audit report may be used as a basis for legal action to enforce the contract, to terminate the contract, and/or to collect royalties and damages.

The royalty audit is generally performed in three phases: (1) pre-site work, (2) site work, and (3) post-site work. Phase 1 includes an analysis of all relevant information prior to the site visit. Prior to a site visit, an auditor may also request that certain documentation, books, and records be made available for inspection. Phase 2 includes site work, which typically lasts two to five days. During site work, the auditor interviews the licensee's management and employees, and analyzes and evaluates relevant information. To ensure the completeness of reported licensed sales, the auditor often needs to examine products other than those that are reported to be licensed. For example, they often inspect the specifications of other products to determine whether unreported sales may qualify as licensed product sales. Phase 3 is completion of the report. After completing the site work, the audit team prepares its draft conclusions or report. Depending on the situation, this report is discussed with the licensor and sometimes with the licensee. If required, requests

⁸ Royalty audits are often done sporadically and randomly, unless the licensors are privately informed of their licensees' suspicious activities. A recent study by royalty auditors reports that conditional on there being a royalty audit, 86 percent of licensees are found to underreport royalties (Stewart et al. 2017).

for additional information or follow-up visits are made before a final report is issued. While the final report includes the summary of detected misstatements, if any, the auditor does not necessarily issue an opinion on whether such misstatements are due to unintentional errors and irregularities or intentional misreporting by the licensee—unless the licensor is bringing the issue to court.⁹

Given the extensive involvement of the licensee’s personnel throughout the royalty audit, it is not costless for the licensee to grant the full scope of audit rights to the licensor. Frequent audits can be time-consuming and disruptive to the licensee’s business. By allowing broader scope audits, the licensee bears additional costs of preparing and hosting the audits, as well as taking actions to address any gaps in compliance once each audit is completed. Even though the licensor may not actually exercise its full audit rights, the licensee must be prepared to respond to allowable audit requests. Thus, the licensee will resist granting excessive contractual audit rights to the licensor.

1.3. Empirical predictions

In the context of technology licensing, audit policies over royalties serve as important enforcement mechanisms that mitigate the information asymmetries surrounding the licensee’s disaggregated accounting information. The licensor may rely on two main enforcement terms—(1) the scope of audit rights and (2) penalties for negative audit results—to detect and deter misreporting by the licensee.

In bilateral negotiation, the two contracting parties (i.e., licensor and licensee) have contradictory demands and must exchange proposals in order to reach a deal. The licensor prefers stringent audit terms while the licensee prefers lenient terms regardless

⁹ This is because proving intent is difficult and requires costly collection of additional evidence.

of the level of misreporting risk to the licensor. Despite these contradictory preferences, the two parties must agree on sufficient enforcement terms in order to facilitate the viability of the contract and reach a deal. Thus, the observed scope of audit rights and penalties will reflect their relative value (cost) to the licensor (licensee).

Relying on prior research in financial auditing, law enforcement, and contract theory, I consider how the scope in these two key audit terms are driven by perceived weaknesses in the licensee's accounting system, reporting flexibility, and incentives to self-enforce.

1.3.1. Perceived accounting system weaknesses

I investigate how *ex ante* signals regarding the reliability of the licensee's accounting system affect the audit terms. Weaknesses in the licensee's overall accounting system are reported to have direct impacts on royalty reporting errors (e.g., Throckmorton 2008; Stewart et al. 2017). Royalties are more likely to be misreported under a weak reporting system, such as a system that has not been accurately programmed, includes erroneous computer algorithms, or is not fully automated (Stewart et al. 2017).¹⁰ Given that royalty audit rights allow the licensor to audit only subsets of the accounts produced by the licensee's accounting system (i.e., only the accounts relevant to royalty terms), the licensor's demand for broader audit rights will vary with the reliability of the licensee's accounting system.

Prior to entering into the contract, the licensor has limited information about the reliability of the licensee's reporting system. The licensor must instead rely on signals regarding the licensee's accounting system reliability and quality. One informative and

¹⁰ Specific examples of misreporting attributable to weak reporting systems include material math errors, unreported sales due to new product numbers being assigned to a second generation or updated products, and application of wrong rates to royalty-bearing products (Stewart et al. 2007).

readily observable signal is the licensee's financial auditor characteristics.¹¹ When the licensee has a lower-quality auditor, the licensor will expect a higher likelihood of reporting weaknesses. Based on this expectation, the licensor will find broader audit rights more valuable.

While perceived accounting system weaknesses are expected to lead the licensor to demand broader audit rights, the theory of enforcement economics suggests that the use of penalties will be less effective on the licensee with perceived weaknesses in reporting systems. Stewart et al. (2017) argue that reporting system weaknesses lead to the majority of *unintended* royalty misreporting. Penalties, on the other hand, work as a deterrent for *intentional* misbehaviors because they increase the licensee's cost of intentional misreporting and thus decrease the net benefits from doing so (Becker 1968). However, the deterrence role of penalties will be largely ineffective in reducing inevitable, unintentional errors, which are produced regardless of the licensee's intent. To the extent that a licensee with a lower-quality auditor is expected to produce more unintentional errors, the licensor will find penalties to be a less effective deterrent than broad audit rights.

The licensee will also have differential preferences for audit rights or penalties depending upon the likelihood of *unintentional* errors. On one hand, if the licensee agrees to grant broader audit rights, the licensee potentially faces the greater burden of responding to frequent audits. On the other hand, if the licensee agrees to explicit penalty terms, it potentially exposes the licensee to penalties for unintentional errors. If the licensee's reporting system is more likely to produce unintentional errors, the licensee faces higher expected penalties due to unintentional errors without necessarily leading to

¹¹ Prior research documents auditor quality is used as a signal of accounting system quality in capital markets (e.g., Krishnan 2003; Khurana and Rama 2004; Mansi et al. 2004).

greater deterrence effects.¹² Thus, the licensee would rather accept broader audit terms than penalties.

Based on preceding arguments, I predict that the licensor and licensee are more likely to agree on broader audit rights when the licensee is perceived to have a less reliable accounting system. In contrast, I expect less use of penalties when the licensee's accounting system is perceived to be less reliable.

1.3.2. Reporting flexibility

The licensee has greater reporting flexibility (i.e., discretion to report royalties opportunistically) when more deductible items are included in the royalty base. The royalty base can range from gross revenues to contractually-defined net revenues, where allowed deductibles (e.g., returns, discounts and transportation costs) are subtracted from gross revenues. These deductions are reported to be frequent sources of *intentional* misreporting due to issues such as unfair allocation of costs relative to underlying economic activities, licensee-favorable interpretations on various deductibles, and failure to incorporate agreement-based limitations to deductions (Stewart and Byrd 2007; Ruey 2013; Nolte 2017). To the extent that these deductibles increase the risk of intentional misreporting by the licensee, the licensor is expected to prefer penalties to a broader audit scope. This prediction is based on the deterrence theory that penalties are more cost-effective in deterring intentional misbehaviors than the threat of audits because audits are more costly from the licensor's perspective (Becker 1968).

The licensee's preference for audit scope versus penalties is expected to depend on the extent of allowed deductibles. More deductibles increase the number of accounts

¹² This prediction is related to Polinsky and Shavell (1979) and Block and Sidak (1980) that suggest the increased chance of penalizing those without fault decreases the desirability of penalties.

subject to royalty audits and thus audit complexity.¹³ This additional complexity makes it more costly for the licensee to host broader scope audits, even if there is no intentional misreporting. Thus, the licensee with more allowed deductibles is more likely to resist granting broader audit rights. In sum, I predict that the licensor and licensee are less (more) likely to agree on broader audit rights (including penalties) when more allowed deductibles increase the licensee's reporting flexibility.

1.3.3. Incentives to self-enforce

The licensee's incentive to "self-enforce" (that is, to ensure accurate royalty reporting) is also expected to influence the audit terms. The licensor has the ability to terminate the contract following a material breach by the licensee, such as intentional underpayments. Contract theory suggests that the opportunity cost of termination can increase the licensee's incentive to self-enforce.¹⁴ Thus, if the contract includes terms that induce self-enforcement, the licensor can reduce its auditing intensity (Lafontaine and Raynaud 2002).

Specifically, I expect that contractual features such as (i) a worldwide license, (ii) a long-term license, and (iii) an exclusive license reduce the need for broader audit rights. Theory suggests that contractual terms that guarantee future expansion opportunities or exclusive market positions can induce self-enforcement because these terms allow the licensee to earn profits that are not dissipated in the long run (Klein 1980, 1995; Lafontaine and Raynaud 2002). A licensee with a worldwide license can access larger markets and potentially generate greater gains by increasing its economies of scale than the licensee

¹³ Audits on gross revenue-based royalties involve inspecting only the revenue accounts, while those on net revenue-based royalties involve reviewing the revenue and other deductible accounts, as well as a greater level of securitizing due to greater likelihood of potential accounting manipulations the licensee may devise.

¹⁴ An extensive theoretical literature focuses on the role of self-enforcement that is induced when a premature termination of the contract is costly to the counterparty (e.g., Telser, 1980; Klein and Leffler, 1981; Williamson 1983, 1985; Klein and Murphy 1988).

with a local license. Similarly, when the license is long term, the licensee is more likely to make relationship-specific investments with less concern for hold-up by the licensor (e.g., Joskow, 1988). These investments will allow the licensee to realize greater returns throughout the contract duration. When the license deal is exclusive between the licensor and the licensee, the licensee is the only firm authorized to utilize and commercialize the technology within the contractual scope. As a result, the licensee likely stands to gain more under the exclusive license than under the non-exclusive license, under which the license may potentially compete against other licensees with the same non-exclusive license. To the extent that the presence of these contractual features increases the licensee's opportunity cost of contract termination and thereby its incentive to self-enforce, I predict that licenses covering more territory, having longer durations, and granting exclusive rights are associated with narrower audit scope.¹⁵

While the contract theory predicts that the terms that induce self-enforcement lower the licensor's monitoring needs, the literature does not factor in the potential role for penalties. Thus, it is an empirical question as to whether the presence of these contractual features would also reduce the need for the penalty terms.

1.4. Data selection, variables of interest and descriptive statistics

1.4.1. Sample selection

I retrieve all technology licensing agreements (TLA) between 1996 and 2015 from KtMine's License Agreement database, which collects material royalty agreements and documents from SEC filings.¹⁶ Licensing agreements are most often included in Exhibit

¹⁵ This prediction is under the assumption that the licensor cannot not fully extract the licensee's increased rents via higher royalties or other payments to the licensor. If the licensor fully extracts the increased rents generated by these contractual features, the presence of these terms will have insignificant impact on the audit scope.

¹⁶ The year 1996 was the first year that the SEC required firms to file electronically. Regulation S-K of the Securities Act of 1933 requires publicly filing companies to include all material contracts

10 attached in a 10-Q or 10-K filing. I rely upon KtMine's coding of basic facts about each agreement including the licensor, licensee, agreement type, royalty rates, licensed territories, and exclusivity provisions. I focus on patent and technology licensing agreements, as coded by KtMine, yielding an initial sample of 2,821 retrieved documents.¹⁷

My sample construction consists of the following steps. First, I read each document to confirm that the retrieved document is a licensing contract. I exclude any misclassified contracts and duplicate filings.¹⁸ Second, I hand-match the names of the contracting parties, using the master filing list in Wharton Research Data Services (WRDS) SEC Suites. I then match the licensor's and licensee's Central Indexing Key (CIK), if there is a match, to Compustat North America (US and Canadian firms) or Compustat Global (international firms). Third, I hand-match the subsample of licensors and licensees with no valid CIK to Thomson Reuters Datastream (international firms) to get a broader coverage over international firms. Finally, I manually read each contract to determine the following variables: the length of auditable periods, the number of allowable audits, audit-fee penalties, interest penalties, contract duration, allowed deductibles, and the licensors'

as exhibits in SEC filings. Material contracts must be attached to the S-1, S-4, S-11, F-1, F-4, 10-Q, 10-K or 8-K for the corresponding period in which the contract is executed.

¹⁷ I acknowledge that data on SEC material contracts have structural limitations. First, observed agreements involve at least one publicly traded firm as a contracting party, which comprise only a subset of all companies. Second, a contract will not be observed if it does not meet the materiality requirements specified in Regulation S-K. Thus, only a subset of agreements, which trigger SEC reporting requirements, will be included in my sample (i.e., agreements that are material to the filing companies). Consequently, my sample may not be representative of the population of TLAs. However, given that my sample survives these two significant filters, the sample contracts will likely be economically significant TLAs.

¹⁸ KtMine database includes other documents or sections of 10K/Q that include discussions on royalties, transfer of patent rights, and licensing deals. I exclude any documents that are not contracts nor facilitate transferring of technologies between contracting parties in return for payments.

obligations for technology support. The resulting dataset is comprised of 975 contracts (Table 1.1).¹⁹

In Table 1.2, columns 1 through 4, I report the distribution of sample licensors and licensees by Fama-French 12-industry classification. Healthcare, Medical Equipment, and Drugs represent the largest portion of licensors and licensees in my sample, followed by Business Equipment.²⁰

1.4.2. Empirical measures of stringency of audit provisions

1.4.2.1. Proxies for the scope of audit rights

I use two proxies for the scope of audit rights granted to the licensors: (i) *Length of Auditable Periods* and (ii) *Unrestricted Audits*.²¹ First, I develop a proxy based on the duration of the licensor's audit rights. The audit provisions limit a royalty audit to certain prior periods. The more prior periods the licensor may go back to audit, the more flexible and cost-effective the licensor can be in its royalty audits. Moreover, the licensor's audit rights are effective beyond the termination of the contract up to the length of its auditable periods. Second, I measure whether the licensor is restricted in the number of allowable

¹⁹ Given the prior empirical evidence on prevalent royalty terms in TLAs, the empirical investigation in this paper is focused on contracts that include royalty licensing. In addition to regular royalty payments, some sample contracts may include some forms of fixed fees such as an initial upfront fee.

²⁰ I report the industry classification of licensor firms from only 457 sample contracts because the industry membership information is not available for licensors that are non-corporate entities (e.g., universities, research centers, and government agencies) or companies with missing financial data. There are 441 contracts where the licensors have non-missing financial data, and 16 contracts where the licensors' industry information is available on Dun & Bradstreet.

²¹ An article by Royalty Compliance Organization explains that contractual audit rights may vary on four dimensions: (1) number of auditable periods, (2) restrictions on allowable audit frequencies, (3) document retention periods, and (4) when an audit may be performed. I only measure the first two dimensions as the audit scope because the third dimension (i.e., document retention periods) typically coincides with the first dimension (i.e., number of auditable periods). That is, for example, if the licensee is required to retain relevant documents for two years (i.e., document retention period=2 years), the licensor may go back two prior years of the licensee's relevant documents (number of auditable periods=2 years), and vice versa. With regards to the fourth dimension (i.e., when an audit may be performed), I find no meaningful variation in my sample as the sample audit terms invariably specify that audits can be done "during normal business hours."

audits in a given year. This variable, *Unrestricted Audits*, captures whether the licensor may audit the licensee anytime with no restriction on the time length between two consecutive audits. While some contracts allow the licensor to audit the licensee any time without any limit on the number of audits, other contracts may restrict the number of audits the licensor may perform on the licensee. For instance, if the contract limits the licensor to one audit per year, at least a year must have passed since the last audit.

1.4.2.2. Proxies for penalties

I utilize two proxies for the penalties on detected underpayments: (i) *Audit Fee Penalties* and (ii) *Interest Penalties*. First, I develop a proxy based on whether the licensee may be charged with incurred audit fees as penalties. By default, the licensor bears audit fees, as it is the licensor's responsibility to monitor the licensee. Some contracts specify that the burden of audit fees be shifted from the licensor to the licensee when certain levels of underpayments are detected in audits. For example, some contracts may trigger the audit fee shifting provisions upon detecting underpayment exceeding a pre-specified threshold (e.g., 10% of actual royalties owed) while other contracts do not include such audit fee penalties (i.e., the licensor bears the audit fees at all times, regardless of the magnitude of detected underpayments).

Second, I measure whether interest is charged on any underpayment detected during an audit. This variable captures interest penalties that the licensee faces in addition to paying back the detected underpayments. Some contracts, for example, specify that the licensee pay interest at the Wall Street Journal prime rate plus $x\%$, while other contracts do not impose any interest penalty.

1.4.3. Proxies for the independent variables of interest

In the following subsections, I describe the empirical proxies for the three main variables of interest: the licensee's perceived accounting system weaknesses (Section

1.4.3.1), reporting flexibility (Section 1.4.3.2), and incentives to self-enforce (Section 1.4.3.3).

1.4.3.1. Proxies for perceived accounting system weakness

Given that the licensor typically has limited information about the licensee's overall reporting system at the time of contracting, the licensor can readily rely on the licensee's financial auditor characteristics as signals of accounting system weaknesses.²² In particular, I use two proxies based on the licensee's financial auditor characteristics. First, I measure whether the licensee's financial auditor is not a big N financial auditor. Prior literature suggests that capital market participants tend to associate clients of big-N auditors with having more reliable accounting systems.²³ Thus, I use an indicator variable for the licensees with non big-N auditors to measure the perceived weaknesses in their accounting systems.

Similarly, I use the financial auditor industry specialization, measured by client industry concentration, as a second signal the licensor can readily observe. The financial auditor's knowledge of the industry is known to increase financial audit quality and improve the accuracy of error detection (e.g. Solomon, Shields, and Whittington 1999; Owoso, Messier, and Lynch 2002). Specialist auditors are also expected to have greater competency and stronger reputation incentives to provide high quality audited financial statements. Following prior studies, I measure auditor industry specialization using the

²² It is important to note that firm-level financial audits do not eliminate the demand for royalty audits because royalty audits are conducted at a finer level than financial audits are conducted. Royalty auditors assess revenue and cost allocations at the product level, while financial statement auditors typically focus on materiality thresholds deemed relevant to acceptable accuracy of overall financial statements.

²³ See Krishnan 2003, Behn et al. 2008, DeFranco et al. 2011, Fan and Wong 2005, Gul et al. 2010, Khurana and Raman 2004, Pittman and Fortin 2004, Mansi et al. 2004, Choi and Wong 2007, Chang et al. 2009.

auditor's within-industry market share. For each auditor and year, industry market share is calculated as follows:

$$MARKETSHARE_{ki} = \frac{\sum_{j=1}^J S_{kij}}{\sum_{i=1}^I \sum_{j=1}^J S_{kij}}$$

where $MARKETSHARE_{ki}$ is the market share of auditor i in industry k , S_{kij} represents the total assets of client firm j in industry k audited by auditor i , I represents the number of audit firms in industry k . Auditors are specialists if they audit 30 percentage of the market (Neal and Riley, 2004). I label this variable *Industry Non-Specialist Financial Auditor*, which takes a value of one if the licensee's auditor is not an industry specialist.

1.4.3.2. Proxies for reporting flexibility

I use the number of allowed deductibles in royalty terms to measure the licensee's reporting flexibility. Most contracts tailor the contractual definition of royalty-bearing sales; some contracts define royalty-bearing sales on gross revenues before deducting any expenses, while other contracts allow a varying degree of deductibles before applying the royalty rates (i.e., gross revenues net of allowed deductibles). The licensee's reporting flexibility increases with the number of allowed deductibles because the licensee may misallocate or make favorable assumptions on these deductibles to underreport royalties (e.g., Ruey 2013). Examples of deductible items include transportation costs and sales commissions. (See Tables 1.3B and 1.3C for the frequency and distribution of deductible items.)

1.4.3.3. Proxies for incentives to self-enforce

I measure three distinct contractual terms that likely increase the licensee's incentive to self-enforce. Theory suggests contractual terms that guarantee future expansion opportunities or exclusive market positions can induce self-enforcement because these terms allow the licensee to earn profits that are not dissipated in the long

run (Klein 1980 & 1995; Lafontaine and Raynaud 2002). Accordingly, a worldwide license and a long-term license will likely provide greater future expansion opportunities to the licensee. In addition, an exclusive license allows the licensee to enjoy exclusive market positions and face lower potential competition. In particular, I use an indicator variable for (i) a worldwide license and (ii) a long-term license and (iii) an exclusive license, respectively, to measure the presence of contractual terms that induce self-enforcement.

1.4.4. Descriptive statistics

Table 1.3 reports the descriptive statistics for the sample. All variables are defined in Appendix 1.A. The average length of auditable periods is 4.06 years. Fifty-one percent of the sample has a limitation on the number of allowed audits per year (i.e., *Unrestricted Audits=0*); the rest of the sample allows for unrestricted audit frequencies in a given year. Fifty-one percent of the sample includes audit fee penalties while 32 percent of the sample imposes interest penalties on underpaid royalties. On average, royalty rates are 11 percent of royalty-bearing sales and 36 percent of the contracts had a duration until the patents expire. Ninety-three percent of the sample licenses is exclusive, and 68 percent of the licenses allows for worldwide sales. Twenty-nine percent of the sample licensees has non Big-N financial auditors, and 84 percent of the licensees has industry non-specialist financial auditors. This implies, 29 percent of the licensees has non Big-N auditors who are also industry non-specialist auditors, and 55 percent of the licensees has industry non-specialist Big-N auditors. Thirty-two percent of the licensors and licensees are in the same industries.

1.5. Research Design

I test the impact of the licensee's accounting system weakness, reporting flexibility and incentives to self-enforce on the stringency of audit terms using the following model:

$$\begin{aligned}
\text{AuditTerm} = & \alpha + \beta_1 \text{PerceivedAcctWeakness} + \beta_2 \text{ReportFlexibility} \\
& + \beta_3 \text{SelfEnforceIncentive} + \lambda \text{ContractChar} \\
& + \gamma \text{OtherControls} + \epsilon
\end{aligned}
\tag{1.1}$$

where the dependent variable is *Length of Auditable Periods*, *Unrestricted Audits*, *Audit Fee Penalties* or *Interest Penalties*. The former two variables are used to measure the licensor's audit rights while the latter two are used for penalties. For ease of interpretation, dependent variables are increasing in stringency of the term. *Perceived Acct Weaknesses* is one of the two measures described in Section 3.3.1., which are *Non-Big N Financial Auditor* and *Industry Non-Specialist Financial Auditor*. I use the number of deductible items in the royalty base to measure *Reporting Flexibility* (See Section 3.3.2.). Lastly, I use three distinct measures of *Self Enforce Incentive: Worldwide License*, *Duration until Patent Expiration*, and *Exclusive License* (See Section 3.3.3.). See Appendix 1.A for variable definitions.

For analyses on the audit rights, I predict that the coefficient on the licensee's perceived accounting system weaknesses to be positive if the licensor demands broader audit rights when the licensee's accounting system is perceived to be less reliable. I also expect the licensee's reporting flexibility will be negatively associated with the audit rights if broader audit rights are less likely to be cost effective deterrents against *intentional* misreporting. I expect when the contract includes terms that induce self-enforcement, the licensor's need for monitoring is likely lowered. Thus, I predict that the licensee's incentive to self-enforce is negatively correlated with the scope of audit rights.

In contrast, for the penalty analyses, I predict that the coefficient on the licensee's perceived accounting system weaknesses is negative to the extent that penalties do not deter inevitable, *unintentional* misreporting. I also expect that the licensee's reporting flexibility will be positively related to the inclusion of penalty terms if the penalties are cost-

effective means of deterring *intentional* misreporting. Lastly, as the relation between the licensee's incentive to self-enforce and the penalties is an empirical question, I do not have a directional prediction on the impact of *Self Enforce Incentive* on the penalty terms.

I include a number of control variables. I control for whether the licensor and licensee are in the same industry because a licensor in the same industry is more likely to be privately informed about the licensee's internal developments and may better assess the impropriety of the licensee's royalty reports. I include whether the licensor is obliged to provide technology support to the licensee because this obligation will likely lead to on-going conversations between the licensor and licensee, serving as an additional information channel for the licensor. I expect the licensor's better access to private information to ease the stringency of the audit right terms.

I also include *Material to Licensee* and *Royalty Rate* to control for the economic significance of the transaction to the licensee. I control for the licensee's size because smaller firms are likely to be more informationally opaque. To the extent that information uncertainty increases the need for broader audit scope, I expect smaller licensee firms to face broader audit scope terms. Finally, I control for the licensee's business uncertainty by including the licensee's profit volatility and product market fluidity (Hoberg et al., 2014) because general uncertainty about the licensee's business and future product demand may increase the licensee's incentives to misreport.²⁴

²⁴ Product market fluidity measures the competitive threats faced by a firm in its product market by capturing changes in rival firms' product space relative to the firm (Hoberg et al., 2014). The measure is available on <http://hobergphillips.usc.edu/industryconcen.htm/>.

1.6. Empirical Results

1.6.1. The scope of audit right analyses

I present the results of the audit right analyses in Table 1.4. In Panels A and B, I report the analyses on *Length of Allowed Audit Periods* and *Unrestricted Audits*, respectively. Consistent with my predictions, I find evidence that the licensee with a non-big N auditor or an industry non-specialist financial auditor is more likely to grant broader audit rights to the licensor, consistent with the licensor valuing broader audit rights on the licensee whose accounting system is perceived to be less reliable.^{25,26} The results in columns 1 and 2 (3 and 4) in Panel A show that licensees with non-big N financial auditors (industry non-specialist financial auditors) are associated with allowing the licensor to go further back to audit prior periods (i.e., longer auditable periods). Moreover, when the licensee has high reporting flexibility, the licensor and licensee agree on narrower audit rights. The coefficients on *Worldwide License* and *Duration until Patent Expiration* are negative, consistent with these contractual features reducing the licensor's need for longer length of audit rights.

Panel B of Table 1.4 also shows that licensees with accounting system weaknesses are positively associated with granting the right to audit without restricting the frequencies.²⁷ The coefficients on *Non-big N financial auditors (Industry non-specialist*

²⁵ In additional analyses, I use the indicators for internal control material weakness (ICMW) and Accounting and Auditing Enforcement Releases (AAER) in the prior year to proxy for perceived weaknesses in the licensee's accounting system. However, there are only 57 observations with ICMW (i.e., *ICMW=1*) and 13 observations with AAER (i.e., *AAER=1*). I find insignificant results with these proxies. See Appendix E.

²⁶ In additional analyses, I use the abnormal audit fee to proxy for audit quality after controlling for determinants of audit fees, following Ettredge, Li, and Scholz (2007). To the extent that audit fees reflect efforts by financial auditors, greater abnormal audit fees may signal lower concerns for accounting system weaknesses. I find that positive abnormal audit fee are negatively associated with audit scope, consistent with my prediction. Due to data availability of audit fees, the analysis is limited to a subsample of 385 observations between 2003 and 2015. The results are reported in Appendix F.

²⁷ I find consistent results using the logit and probit regressions with the same set of variables.

financial auditors) are positive, though statistically significant only for the licensee with non-big N financial auditors. In addition, *Number of Deductible Items* are negatively correlated with the tendency to including the audit right with unrestricted frequencies, consistent with audit scopes being less effective in deterring *intentional* misreporting. The coefficients on *Worldwide license* and *Duration until Patent Expiration* are negative and statistically significant, consistent with the self-enforcement theory that the licensee's incentive to self-enforce reduces the licensor's need for audits.

In columns (2) and (4) in Panels A and B, I add industry fixed effects to the regressions to eliminate alternative explanations for cross-industry differences in contract design. The results show that within-industry variation in the variables of interest (i.e., the licensee's perceived accounting system weakness, reporting flexibility and incentive to self-enforce) affects the scope of the licensor's audit rights in the predicted manners.

1.6.2. *The penalty analyses*

In Table 1.5, I report the results of the penalty analyses. In Panels A and B, I report the analyses on *Audit Fee Penalties* and *Interest Penalties*, respectively. As predicted, I find that as the licensee's reporting flexibility increases, the probability of imposing penalties increases. The results in columns 1 through 4 in Panel A show that the greater number of allowed deductibles associated with including audit fee penalties in the contracts. This is consistent with the deterrence role of penalties being more effective on those with greater ability to misreport. I also find weak evidence that the penalty terms are less likely to be imposed on the licensee with industry non-specialist financial auditors, consistent with the law enforcement theory that the deterrence effects of penalties are lower for the licensee with a greater likelihood of unintentional errors (i.e., without fault). The coefficients on *Exclusive License* and *Duration until Patent Expiration* are positive and statistically significant.

Similarly, Panel B of Table 1.5 shows that the number of allowed deductibles is positively associated with imposing interest penalties on underpaid royalties. In columns 1 and 2 (3 and 4), the coefficients on *Non-Big N financial auditor (Industry non-specialist financial auditor)* are negative, though the coefficients are statistically significant only on *Industry non-specialist financial auditor*. Contracts with *Exclusive license* and *Duration until Patent Expiration* are more likely to include interest penalties. I add industry fixed effects to the regressions in columns 2 through 4 of Panels A and B, and find consistent results.

In additional analyses, I develop a dependent variable that combines *Audit Fee Penalties* and *Interest Penalties* such that the variable takes the value of two if including both of the penalties, one if including either of the penalties, and zero if including no penalty terms; the variable is increasing in the stringency of the combined penalty terms. Using this new measure, I repeat the penalty analyses and find consistent results. Moreover, the results are qualitatively similar using OLS, multinomial logit, and probit regressions (See Appendix 1.D).

1.7. Potential threats to the paper's inferences

For empirical tractability, my analysis is limited to observable audit terms. Contracting parties may rely on other contractual terms or unobservable monitoring mechanisms rather than on audit terms to mitigate misreporting risks. The purpose of this section is to discuss potential alternative mechanisms and address them in additional tests, as well as to note several caveats of this study.

1.7.1. Royalty terms as alternative mechanisms to mitigate misreporting risk

Institutionally, the contracting parties tend to negotiate and determine the royalty terms and *then* tailor the audit terms to meet the enforcement needs for the determined royalty terms. However, an alternative argument may be that the contracting parties adjust

the royalty terms, instead of audit terms, to mitigate the licensor's misreporting risk. To address this concern, I investigate the determinants of the royalty characteristics: (1) royalty rates, and (2) royalty bases.

First, the licensor may increase royalty rates in order to price-protect its claims against potential losses due to the licensee's misreporting, thereby reducing the audit needs. To mitigate this concern, I control for royalty rates in the main analyses (Tables 4 and 5). Furthermore, in an additional test, I examine whether the licensee's perceived weaknesses in the accounting system and reporting flexibility have statistically significant effects on the royalty rates. Theoretically, royalty rates are determined by the licensor's contribution to the licensee's licensed sales (e.g., Stiglitz 1974). Thus, I expect the royalty rates to increase with the licensor's contribution to the contractual relationship, such as its obligations to provide technical support to the licensee throughout the contract duration. Alternatively, however, if the licensor relies on higher royalty rates to compensate for higher misreporting risk, the perceived weaknesses in the licensee's accounting systems and reporting flexibility should lead to greater royalty rates. I test this alternative argument using the following model:

$$\begin{aligned}
 \text{RoyaltyRates} = & \alpha + \beta_1 \text{PerceivedAcctWeakness} + \beta_2 \text{ReportFlexibility} \\
 & + \beta_3 \text{SelfEnforceIncentive} + \lambda \text{ContractChar} + \gamma \text{OtherControls} \\
 & + \epsilon
 \end{aligned}
 \tag{1.2}$$

where the dependent variable is either *Royalty Rates*. I measure *Perceived Acct Weaknesses* as either *Non-Big N Financial Auditor* or *Industry Non-Specialist Financial Auditor* (See Section 1.4.3.1.). I measure *Reporting Flexibility* by using the number of deductible items (See Section 1.4.3.2.).

Second, the contracting parties may adjust the royalty bases (i.e., number of deductible items) to limit the licensee's reporting flexibility and reduce the misreporting

risk. Prior theoretical research suggests that the extent of allowed deductibles (i.e., cost sharing) for royalties is motivated by risk sharing considerations (i.e., sharing uncertainty in environment changes) (e.g., Braverman and Stiglitz 1986; Allen and Lueck 1995 & 1999). I expect that the extent of cost sharing is greater when the contractual relationships are exposed to greater uncertainty. Alternatively, however, if the contracting parties reduce the number of deductible items in the royalty base to reduce misreporting risk, the perceived weaknesses in the licensee's accounting systems should lead to fewer deductible items in the royalty base. In order to test this alternative argument, I investigate whether the independent variables of interest in this study have an impact on the royalty bases, using the following model:

$$\begin{aligned}
 \text{RoyaltyBase} = & \alpha + \beta_1 \text{PerceivedAcctWeakness} + \beta_2 \text{SelfEnforceIncentive} & (1.3) \\
 & + \lambda \text{ContractChar} + \gamma \text{OtherControls} + \epsilon
 \end{aligned}$$

where the dependent variable is *Number of Deductible Items*. I measure *Perceived Acct Weaknesses* as either *Non-Big N Financial Auditor* or *Industry Non-Specialist Financial Auditor* (See Section 3.3.1.). I use three distinct measures for *Self Enforce Incentive*: *Exclusive License*, *Worldwide license* and *Duration until Patent Expiration* (See Section 3.3.3.).

In Table 1.6, I report the determinants of *Royalty Rate* and *Number of Deductible Items*. Panel A shows results from estimating equation (1.2). I find little evidence that the licensor's misreporting risk has first-order effects on *Royalty Rate*; perceived accounting system weaknesses are statistically insignificantly related to *Royalty Rate*. The coefficient on the licensee's reporting flexibility is also insignificant. However, I find that the licensee pays lower royalty rates (i.e., retains greater portions of the sales) when the licensee's

product market is exposed to greater volatility, or when the contract has a long duration.²⁸ Supporting the prior theory, I also find that the licensor's obligations to provide technology support to the licensee increase royalty rates. This finding is consistent with the royalty rates capturing the licensor's relative contribution to the contractual relationship (e.g., Lafontain and Reynaud 2002).

Panel B of Table 1.6 reports the determinants of *Number of Deductible Items*, showing results from estimating equation (1.3). I find no evidence that perceived accounting system weaknesses have first-order impact on the royalty bases (i.e., *Number of Deductible Items*). However, I find that *Worldwide License*, *Duration until Patent Expiration* (i.e., long contract duration) and *Licensee Volatility* are positively correlated with the number of deductible items. To the extent worldwide sales, long contractual durations, and volatile business environments are exposed to greater future uncertainty, these findings are consistent with the theoretical prediction that greater future uncertainty leads to the greater extent of cost sharing (e.g., Allen and Lueck 1995 & 1999).

²⁸ A potential explanation for this finding is that lower royalty rates allow the licensee to retain greater residual claims and thereby can serve as an incentive mechanism (Lafontain and Reynaud 2002). To the extent that long-term contracts are associated with higher levels of relationship-specific investments by the licensee (e.g., Joskow 1988), lower royalty rates can provide additional incentives for the licensee to make relationship-specific investments.

Overall, while the determinants of royalty characteristics are largely consistent with prior theoretical predictions, I do not find evidence supporting the potential alternative argument that royalty terms are used to mitigate the licensor's misreporting risk.²⁹³⁰

1.7.2. Implicit contractual terms

The contractual settings have potential limitations because the contracting parties may rely on implicit terms that are not observable in the contracts. Alternatively, unobservable monitoring mechanisms might substitute for explicit audit provisions. Although it is impossible to fully account for all implicit terms, I test for a potential mechanism that the licensors may use to put pressure on the licensees to improve their reporting quality: a change in financial auditors prior to signing the contracts. To test this potential mechanism, I investigate the licensees' likelihood of changing their financial auditors prior to entering the contracts, relative to other firms in the same industry-year. In subsequent tests, I also examine the likelihood of auditor changes among a subsample of licensee firms with big N financial auditors.

In Table 1.7, I report the difference in mean likelihoods of changing financial auditors prior to entering the contracts. In Panel A, I find little evidence that licensee firms are more likely to change their auditors than other firms in the same industry-year. In Panel B, I restrict the analysis to a subsample of firms with big N financial auditors at the time of

²⁹ Nevertheless, given that there is no exogenous variation in the royalty characteristics nor any other contractual terms, I acknowledge that these additional analyses fall short of addressing endogeneity concerns due to the simultaneous nature of contract negotiation. I also recognize that there might be potential sample selection biases because a contract is included in my sample if it meets the materiality requirements under Regulation S-K, has non-missing financial data, and has unredacted audit terms. In addition, I do not observe failed negotiations or contracts among privately-held firms. Thus, the sample in this study may not be representative of the population of technology license agreements, and the findings should therefore be interpreted with these caveats in mind.

³⁰ I use the determinant model specified in Eq (1.2) to compute abnormal royalty rates (i.e., residual values) and re-run my main analyses using the abnormal royalty rates as a control, instead of raw royalty rates as reported in Tables 1.4 and 1.5. The results are qualitatively similar.

entering the contracts.³¹ I find statistically insignificant differences in the licensees' likelihood of changing their financial auditors prior to signing the contracts. Overall, I do not find evidence supporting the alternative argument that licensors demand financial auditor changes as an implicit enforcement mechanism.³²

1.7.3. *Bargaining power*

Another threat to my inferences is the potential effects of bargaining power. Although my main tests include the licensee's firm size (*Licensee Size*) and whether the licensee and licensor belong to the same industry (*Same Industry*) to partially control for bargaining power, I perform additional analyses to mitigate concerns related to bargaining power. I include a proxy for bargaining power that increases in value as the licensor's relative size increases. In Table 1.8, I find results consistent with the main results from Sections 5.1 and 5.2 after explicitly controlling for bargaining power.

In addition, the bargaining power between the licensor and licensee may change as they engage in repeated transactions. However, given that I can only assess *material* agreements disclosed in SEC filings, I cannot observe all repeated contracts. Only 42 contracts out of 975 sample contracts include repeated licensor-licensee pairs. I drop these contracts with repeated licensor-licensee pairs and repeat the main analyses estimated from Eq (1.1). I find consistent results (See Appendix 1.G Panel A). I also find consistent results when I cluster standard errors by repeated licensors and licensees (See Appendix 1.G Panel B).

³¹ Throughout the study, I measure all the variables for the licensee's firm characteristics, including financial auditor characteristics, in the year prior to entering into the contract. For consistency, I use a subsample of licensees that have big N financial auditors one year prior to signing the contract (i.e., at t-1). However, for robustness, I repeat the analysis using a subsample of firms with big N auditors in the year of contract and find similar results.

³² Nevertheless, I acknowledge the caveats of this study that other implicit, unobservable terms may still substitute for the explicit audit terms.

1.8. Conclusions

This paper examines how perceived weaknesses in the licensee's accounting system, reporting flexibility, and incentives to self-enforce influence the design of two key audit terms in technology licensing contracts—(1) scope of audit rights, and (2) penalties for negative audit results. This paper shows that perceived weaknesses in the licensee's accounting system lead to broader audit rights and lower reliance on penalties. These findings are consistent with licensors demanding broader audit rights and relying less on penalty terms, when licensees' accounting systems are perceived to be less reliable and produce more *unintentional* errors. When the licensee has high reporting flexibility due to the inclusion of more allowed deductibles, penalties are more likely to be used as a deterrent, while broader audit rights that increase the threat of more frequent, intrusive audits are less likely to be employed. These findings are consistent with penalties being more cost-effective deterrents to *intentional* misreporting. I also show that licenses covering more territory and having longer durations are associated with less stringent audit scope terms, consistent with the self-enforcement theory that the higher opportunity cost of early termination associated with greater expansion opportunities induces the licensee to self-enforce, thereby reducing the licensor's need for audits. These results are not driven by the licensors price-protecting themselves against the misreporting risk via higher royalty rates. Overall, my findings suggest that audit scope and penalties can improve contracting efficiency differentially, depending upon the contractual parties' concerns regarding unintentional and intentional misreporting.

The evidence in this paper highlights that external verifiability of accounting information can serve an important role in intangible asset transactions, such as technology licensing. Firms can reduce the *ex ante* risk of undercharging or overpaying for intangibles by allowing the future realized value to determine the payment terms (i.e.,

royalties). Taking advantage of external verifiability of accounting information, firms can rely on disaggregated accounting proxies to capture the realized value of the intangibles and design the audit terms to enforce the accuracy of the accounting-based payments. Consequently, the reliability of accounting systems is an important factor in negotiating and facilitating these intangible asset transactions. I also provide evidence that penalty terms, in addition to audit scope, can be used to mitigate accounting-related information asymmetry problems. Taken together, these results highlight how accounting information and auditing can facilitate contracting on intangible assets.

Although my study focuses on technology licensing agreements, a combination of accounting-based royalties and contractual audit terms is commonly used in many contracts involving intellectual properties or transfer of intangible properties. For example, royalty terms are often used in transacting on trademarks, book publishing, music, film, and software—all of which can be protected under intellectual property laws. In these royalty-based contracts, contractual audit terms are ubiquitous enforcement terms. In addition, franchise contracts are another type of agreements that rely on sales-based royalty and audit terms because the intangible assets (e.g., brand name and know-hows of franchisors) involved in the transactions create contracting problems (Lafontaine and Raynaud, 2002). To the extent that the combination of accounting-based royalties and contractual audit terms is used to mitigate contractual hazards associated with intangible assets, I expect my results to generalize beyond technology licensing settings.

Table 1.1. Sample selection

This table presents my sample selection process.

Filters	Contracts	
KtMine License Agreement Database ¹		2,231
Excluding Other Contracts ²	–	634
		1,597
Excluding licensees with missing data ³	–	622
		975

¹ For the period from January 1996 to December 2015, I search KtMine License Agreement Database for all royalty contracts for technology licensing using the filter “patent” and “technology” in the search options.

² As a second filter, I manually read each contract and eliminate observations that are not technology license agreements (TLA) or do not have royalty components. KtMine database occasionally misclassifies other types of agreements or documents. I drop these misclassified documents and duplicate filings.

³ I require the public licensees to have non-missing Compustat data and all contract-specific variables.

Table 1.2. Distribution of firms by industry

This table reports the distribution of firms by Fama-French 12 industries. The first two columns report the distribution of 457 licensors and 975 licensees from my sample of 975 contracts. Among 975 contracts, 518 licensors are missing the industry classification because they are either non-corporate entities (e.g., research institutes, universities, and government agencies), privately-held companies, or publicly-traded companies with missing financial data on Compustat.

Industry Description	Licensors		Licensees	
	Number (1)	%Frequency (2)	Number (3)	%Frequency (4)
Consumer Non Durables	13	2.84%	20	2.05%
Consumer Durables	3	0.66%	18	1.85%
Manufacturing	15	3.28%	53	5.44%
Energy Oil, Gas, and Coal Products	0	0.00%	7	0.72%
Chemicals and Allied Products	9	1.97%	35	3.59%
Business Equipment	74	16.19%	155	15.90%
Telephone and Television Transmission	3	0.66%	12	1.23%
Wholesale, Retail, and Some Services	9	1.97%	29	2.97%
Healthcare, Medical Equipment, and Drugs	282	61.71%	556	57.03%
Finance	16	3.50%	20	2.05%
Other	33	7.22%	70	7.18%
TOTAL	457	100.0%	975	100.0%

Table 1.3. Descriptive statistics

Panel A of this table presents all descriptive statistics for the sample contracts. In Panel B, I report descriptive details of the deductible items allowed in royalty calculation. In columns 1 and 2 of Panel B, I report the frequencies of deductible items for the total sample of royalty contracts. There are 225 contracts that do not include any deductible expenses (i.e., “Gross Revenue”), and 750 contracts that include at least one deductible item. Among those 750 contracts, 403 contracts allow deducting allowance accounts; 600 contracts allow deducting transportation & handling expenses; and 161 contracts allow deducting sales commissions. In Panel C, I report the frequency for the total number of deductible items allowed in royalty calculation. All variables are defined in Appendix 1.A.

Panel A: Descriptive statistics

Variable	(1) N	(2) mean	(3) sd	(4) p5	(5) p10	(6) p25	(7) p50	(8) p75	(9) p90	(10) p95
Audit Terms										
<i>Length of Auditable Periods (years)</i>	975	4.056	1.345	1	2	3	5	5	5	7
<i>Unrestricted Audits</i>	975	0.490	0.500	0	0	0	0	1	1	1
<i>Audit Fee Penalties</i>	975	0.509	0.500	0	0	0	1	1	1	1
<i>Interest Penalties</i>	975	0.316	0.465	0	0	0	0	1	1	1
Contract Characteristics										
<i>Royalty %</i>	975	10.748	13.862	0.5	1.125	3	5	10	50	50
<i>Worldwide License</i>	975	0.676	0.468	0	0	0	1	1	1	1
<i>Excl. License</i>	975	0.926	0.262	0	0	1	1	1	1	1
<i>Material to Licensee</i>	975	0.778	0.415	0	0	1	1	1	1	1
<i>Duration until Patent Expiration</i>	975	0.362	0.481	0	0	0	0	1	1	1
<i>Licensor's Tech Support</i>	975	0.265	0.453	0	0	0	0	1	1	1
<i>No of Deductible Items</i>	975	1.958	1.298	0	0	1	2	3	4	4
Firm Characteristics										
<i>Licensee Size (\$M)</i>	975	2960.298	9815.305	0.006	0.508	7.863	56.015	342.101	19118	46420
<i>Licensee Volatility</i>	975	1.255	3.953	0.201	0.027	0.063	0.172	0.538	2.686	6.951
<i>Non-Big N Financial Auditor</i>	975	0.286	0.452	0	0	0	0	1	1	1
<i>Industry Non-Specialist Financial Auditor</i>	975	0.84	0.367	0	0	1	1	1	1	1
<i>Same Industry</i>	975	0.322	0.468	0	0	0	0	1	1	1
<i>Product Market Fluidity</i>	975	9.348	4.225	0.513	3.445	5.974	9.118	12.322	16.448	20.263

Table 1.3: Panel B

Allowed Deductible Items	Total Sample	
	N	%Freq
	(1)	(2)
None (<i>Gross Revenue</i>)	225	23.08
Returns and Discounts	750	76.92
Sales Allowances	348	35.69
Allowance for Doubtful Accounts	158	16.21
Transportation & Handling	600	61.54
Sales Commissions	161	16.41

Table 1.3: Panel C

Total number of deductible items	(1)	(2)
	Freq.	Percent
0	225	23.08
1	84	8.62
2	253	25.95
3	251	25.74
4	137	14.05
5	25	2.56
Total	975	

Table 1.4. The audit scope analysis

In this table, I report the results from Eq. (1) where the dependent variable captures the stringency of the scope of audit rights. The dependent variable in Panels A is the length of auditable periods. The dependent variable in Panel B is whether the licensor has an unrestricted number of audits in a given year. Columns (1) through (4) in each Panel report the results for different specifications of the licensee's accounting system weakness. Columns (2) and (4) include industry fixed effects. Standard errors are heteroscedasticity robust. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All variables are defined in Appendix 1.A.

Panel A. Measure of audit scope: Length of auditable periods

Variable	Pre-dicted	<i>Length of Auditable Periods</i>			
		(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	+	0.181* (0.0949)	0.178* (0.0965)		
<i>Industry Non-Specialist Financial Auditor</i>	+			0.292** (0.116)	0.309*** (0.116)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	-	-0.174*** (0.0305)	-0.168*** (0.0311)	-0.175*** (0.0304)	-0.168*** (0.0311)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	-	-0.184** (0.0911)	-0.188** (0.0893)	-0.194** (0.0905)	-0.199** (0.0886)
<i>Duration until Patent Expiration</i>	-	-0.0539 (0.0930)	-0.0330 (0.0942)	-0.0691 (0.0928)	-0.0471 (0.0939)
<i>Excl. License</i>	-	0.124 (0.148)	0.117 (0.146)	0.129 (0.148)	0.125 (0.145)
OTHER CONTRACT CHAR.					
<i>Licensor's Tech Support</i>		-0.221** (0.0928)	-0.200** (0.0937)	-0.231** (0.0920)	-0.211** (0.0927)
<i>Material to Licensee</i>		-0.109 (0.120)	-0.121 (0.119)	-0.115 (0.119)	-0.129 (0.118)
<i>Royalty %</i>		-0.00309 (0.00292)	-0.00227 (0.00298)	-0.00308 (0.00292)	-0.00223 (0.00298)
LICENSEE FIRM CHAR.					
<i>Licensee Size</i>		-1.223** (0.582)	-1.232** (0.584)	-1.205** (0.567)	-1.200** (0.570)
<i>Licensee Volatility</i>		-0.0521*** (0.000694)	-0.0619*** (0.000768)	-0.0482*** (0.000713)	-0.0584*** (0.000786)
<i>Licensee Product Market Fluidity</i>		-0.0167 (0.0109)	-0.0201* (0.0117)	-0.0142 (0.0110)	-0.0172 (0.0118)
<i>Same Industry</i>		-0.151 (0.102)	-0.187* (0.108)	-0.139 (0.101)	-0.173 (0.107)
Industry FE		NO	YES	NO	YES
Observations		975	975	975	975
R-squared		0.094	0.105	0.096	0.108

Table 1.4: Panel B. Measure of audit scope: Unrestricted audit

Variable	Pre-dicted	Unrestricted Audits			
		(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	+	0.0764** (0.0346)	0.0694* (0.0358)		
<i>Industry Non-Specialist Financial Auditor</i>	+			0.0521 (0.0412)	0.0531 (0.0412)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	-	-0.0565*** (0.0115)	-0.0573*** (0.0118)	-0.0570*** (0.0114)	-0.0575*** (0.0118)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	-	-0.0606* (0.0332)	-0.0605* (0.0331)	-0.0618* (0.0331)	-0.0617* (0.0331)
<i>Duration until Patent Expiration</i>	-	-0.160*** (0.0337)	-0.155*** (0.0341)	-0.166*** (0.0339)	-0.160*** (0.0342)
<i>Excl. License</i>	-	0.0166 (0.0540)	0.0191 (0.0541)	0.0178 (0.0538)	0.0208 (0.0539)
OTHER CONTRACT CHARACTERISTICS					
<i>Licensor's Tech Support</i>		-0.0598* (0.0331)	-0.0545 (0.0337)	-0.0629* (0.0329)	-0.0576* (0.0335)
<i>Material to Licensee</i>		0.106*** (0.0407)	0.0954** (0.0410)	0.112*** (0.0410)	0.0996** (0.0413)
<i>Royalty %</i>		0.0122 (0.0105)	0.0133 (0.0109)	0.0123 (0.0105)	0.0134 (0.0109)
LICENSEE FIRM CHARACTERISTICS					
<i>Licensee Size</i>		-0.143 (0.184)	-0.148 (0.180)	-0.162 (0.184)	-0.161 (0.179)
<i>Licensee Volatility</i>		-0.0948** (0.0395)	-0.0115*** (0.0421)	-0.0916** (0.0397)	-0.0110*** (0.0421)
<i>Licensee Product Market Fluidity</i>		-0.0160*** (0.00306)	-0.0201*** (0.00361)	-0.0142*** (0.00283)	-0.0186*** (0.00339)
<i>Same Industry</i>		-0.114*** (0.0363)	-0.126*** (0.0382)	-0.116*** (0.0368)	-0.125*** (0.0386)
Industry FE		NO	YES	NO	YES
Observations		975	975	975	975
R-squared		0.162	0.178	0.159	0.176

Table 1.5. The penalty analysis

In this table, I report the results from Eq. (1) where the dependent variable captures the inclusion of penalties. The dependent variable in Panels A is whether the burden of audit fee is shifted to the licensee if misreported royalties are detected. The dependent variable in Panel B is whether interest is charged on underpayments. Columns (1) through (4) in each Panel report the results for different specifications of the licensee's accounting system weakness. Columns (2) and (4) include industry fixed effects. Standard errors are heteroscedasticity robust. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All variables are defined in Appendix 1.A.

Variable	Pre-dicted	<i>Audit Fee Penalties</i>			
		(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	-	0.0437 (0.0342)	0.0444 (0.0344)		
<i>Industry Non-Specialist Financial Auditor</i>	-			-0.0783* (0.0413)	-0.0763* (0.0413)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	+	0.0923*** (0.0111)	0.101*** (0.0113)	0.0914*** (0.0110)	0.100*** (0.0113)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	?	0.0493 (0.0338)	0.0488 (0.0338)	0.0534 (0.0337)	0.0535 (0.0338)
<i>Duration until Patent Expiration</i>	?	0.142*** (0.0342)	0.142*** (0.0345)	0.140*** (0.0341)	0.140*** (0.0344)
<i>Excl. License</i>	?	0.180*** (0.0566)	0.184*** (0.0573)	0.180*** (0.0575)	0.183*** (0.0583)
OTHER CONTRACT CHAR.					
<i>Licensor's Tech Support</i>		-0.0596 (0.0340)	-0.0112 (0.0341)	-0.0592 (0.0341)	-0.0116 (0.0342)
<i>Material to Licensee</i>		-0.0468 (0.0431)	-0.0387 (0.0423)	-0.0320 (0.0432)	-0.0239 (0.0424)
<i>Royalty %</i>		-0.0128 (0.0103)	-0.0149 (0.0103)	-0.0126 (0.0103)	-0.0149 (0.0104)
LICENSEE FIRM CHAR.					
<i>Licensee Size</i>		-0.165 (0.177)	-0.123 (0.172)	-0.216 (0.172)	-0.171 (0.167)
<i>Licensee Volatility</i>		0.0459 (0.0396)	0.0625 (0.0418)	0.0362 (0.0398)	0.0547 (0.0420)
<i>Licensee Product Market Fluidity</i>		0.0134*** (0.00249)	0.0113*** (0.00344)	0.0146*** (0.00241)	0.0125*** (0.00347)
<i>Same Industry</i>		0.0827 (0.0352)	0.0280 (0.0372)	-0.0268 (0.0358)	0.0201 (0.0377)
Industry FE		NO	YES	NO	YES
Observations		975	975	975	975
R-squared		0.145	0.167	0.147	0.168

Table 1.5: Panel B. Measure of penalty: Interest penalties

Variable	Pre-dicted	Interest Penalties			
		(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	-	-0.0188 (0.0323)	-0.0116 (0.0333)		
<i>Industry Non-Specialist Financial Auditor</i>	-			-0.119*** (0.0424)	-0.113*** (0.0428)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	+	0.0515*** (0.0105)	0.0473*** (0.0109)	0.0511*** (0.0106)	0.0468*** (0.0109)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	?	-0.0105 (0.0311)	-0.00902 (0.0307)	0.0391 (0.0314)	0.0447 (0.0309)
<i>Duration until Patent Expiration</i>	?	0.0792** (0.0337)	0.0744** (0.0342)	0.0818** (0.0334)	0.0763** (0.0340)
<i>Excl. License</i>	?	0.0862* (0.0482)	0.0847* (0.0486)	0.0845* (0.0489)	0.0826* (0.0493)
OTHER CONTRACT CHARACTERISTICS					
<i>Licensor's Tech Support</i>		0.0655** (0.0325)	0.0763** (0.0329)	0.0681** (0.0324)	0.0783** (0.0327)
<i>Material to Licensee</i>		0.0963** (0.0401)	0.0865** (0.0410)	0.107*** (0.0404)	0.0971** (0.0413)
<i>Royalty %</i>		0.0197* (0.0112)	0.0208* (0.0112)	0.0198* (0.0112)	0.0207* (0.0113)
LICENSEE FIRM CHARACTERISTICS					
<i>Licensee Size</i>		0.368** (0.167)	0.344** (0.166)	0.333* (0.172)	0.308* (0.171)
<i>Licensee Volatility</i>		0.0929** (0.0375)	0.0586 (0.0403)	0.0808** (0.0376)	0.0474 (0.0403)
<i>Licensee Product Market Fluidity</i>		0.0121*** (0.00291)	0.0117*** (0.00347)	0.0119*** (0.00282)	0.0117*** (0.00333)
<i>Same Industry</i>		0.0776** (0.0358)	0.0456 (0.0378)	0.0682* (0.0356)	0.0378 (0.0375)
Industry FE		NO	YES	NO	YES
Observations		975	975	975	975
R-squared		0.090	0.100	0.098	0.107

Table 1.6. The determinants of royalty characteristics

This table reports the results from regressions investigating the determinants of royalty characteristics as specified in Equations (1.2) and (1.3). In Panel A, the dependent variable is royalty rates. Panel B reports the results where the dependent variable is equal to the number of deductible items allowed in royalty calculation. In columns (2) and (4) in each Panel, industry fixed effects are included. Standard errors are heteroscedasticity robust. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All variables are defined in Appendix 1.A

Panel A. Measure of royalty characteristics: Royalty rate

Variable	Royalty %			
	(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES				
<i>Non-Big N Financial Auditor</i>	0.238 (0.998)	0.132 (1.047)		
<i>Industry Non-Specialist Financial Auditor</i>			0.155 (1.264)	-0.0634 (1.266)
REPORTING FLEXIBILITY				
<i>No of Deductible Items</i>	-0.279 (0.288)	-0.235 (0.292)	-0.281 (0.288)	-0.236 (0.292)
SELF ENFORCE INCENTIVE				
<i>Worldwide License</i>	0.436 (0.926)	0.357 (0.953)	0.433 (0.928)	0.363 (0.953)
<i>Duration until Patent Expiration</i>	-1.676* (0.954)	-1.595 (0.970)	-1.694* (0.946)	-1.603* (0.962)
<i>Excl. License</i>	2.292* (1.265)	2.361* (1.319)	2.296* (1.265)	2.361* (1.319)
OTHER CONTRACT CHARACTERISTICS				
<i>Licensor's Tech Support</i>	3.477*** (1.052)	3.130*** (1.094)	3.468*** (1.051)	3.127*** (1.094)
<i>Material to Licensee</i>	-2.267 (1.514)	-2.264 (1.514)	-2.250 (1.542)	-2.238 (1.545)
LICENSEE FIRM CHARACTERISTICS				
<i>Licensee Size</i>	7.306 (5.966)	8.081 (5.982)	7.246 (5.938)	7.998 (5.950)
<i>Licensee Volatility</i>	0.0235 (0.114)	0.0884 (0.123)	0.0245 (0.116)	0.0877 (0.125)
<i>Licensee Product Market Fluidity</i>	-0.0217*** (0.00666)	-0.0158* (0.00897)	-0.0212*** (0.00634)	-0.0155* (0.00874)
<i>Same Industry</i>	2.405** (1.136)	3.039*** (1.171)	2.399** (1.121)	3.028*** (1.162)
Industry FE	NO	YES	NO	YES
Observations	975	975	975	975
R-squared	0.048	0.058	0.048	0.058

Table 1.6: Panel B. Measure of royalty characteristics: Royalty base

Variable	<i>No of Deductible Items</i>			
	(1)	(2)	(3)	(4)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES				
<i>Non-Big N Financial Auditor</i>	-0.103 (0.0987)	-0.0637 (0.0972)		
<i>Industry Non-Specialist Financial Auditor</i>			-0.0727 (0.121)	-0.0685 (0.111)
SELF ENFORCE INCENTIVE				
<i>Worldwide License</i>	0.197** (0.0970)	0.178* (0.0942)	0.199** (0.0967)	0.180* (0.0940)
<i>Duration until Patent Expiration</i>	0.703*** (0.0912)	0.571*** (0.0908)	0.711*** (0.0906)	0.576*** (0.0905)
<i>Excl. License</i>	0.0776 (0.176)	0.0512 (0.168)	0.0759 (0.175)	0.0493 (0.168)
OTHER CONTRACT CHARACTERISTICS				
<i>Licensor's Tech Support</i>	0.137 (0.0972)	0.134 (0.0931)	0.141 (0.0969)	0.137 (0.0930)
<i>Material to Licensee</i>	-0.137 (0.116)	-0.171 (0.110)	-0.144 (0.114)	-0.173 (0.108)
<i>Royalty %</i>	-0.00266 (0.00274)	-0.00210 (0.00261)	-0.00268 (0.00274)	-0.00211 (0.00261)
LICENSEE FIRM CHARACTERISTICS				
<i>Licensee Size</i>	0.485 (0.413)	0.124 (0.410)	0.510 (0.412)	0.128 (0.412)
<i>Licensee Volatility</i>	0.0530*** (0.0108)	0.0320*** (0.0115)	0.0526*** (0.0108)	0.0314*** (0.0115)
<i>Licensee Product Market Fluidity</i>	-0.00142 (0.00129)	-0.000704 (0.00138)	-0.00166 (0.00132)	-0.000839 (0.00140)
<i>Same Industry</i>	0.350*** (0.101)	0.176* (0.104)	0.352*** (0.102)	0.174* (0.104)
Industry FE	NO	YES	NO	YES
Observations	975	975	975	975
R-squared	0.152	0.212	0.151	0.212

Table 1.7. Financial Auditor Changes Prior to Entering the Contracts

This table presents whether the sample licensee firms are more likely to change their financial auditors prior to entering the contracts, relative to other firms in the same industries. Panel A presents the difference in mean values for all the licensee firms ($N_1=975$) compared to other firms in the same industry-year with non-missing financial data on Compustat ($N_2=15,096$). Panel B presents the difference for the licensee firms *with big N financial auditors* in the year prior to entering the contract ($N_1=696$) compared to other Compustat firms *with big N financial auditors* in the same industry-year ($N_2=10,136$). *Financial (Big N) Auditor Change* $_{[t-i,t-1]}$ is an indicator variable that takes a value of one if the firm changed its (big N) financial auditors between i years and one year prior to entering the contract; zero otherwise. p -values (two-tailed) test for differences in means and appear in brackets.

Panel A. *Sample licensee firms*

Variable	Licensee Firms		Compustat Firms		Diff. in means	p -value
	Mean	N	Mean	N		
<i>Financial Auditor Change</i> $_{[t-2,t-1]}$	0.18	975	0.18	15096	0.00	[0.90]
<i>Financial Auditor Change</i> $_{[t-3,t-1]}$	0.24	975	0.24	15096	0.00	[0.90]
<i>Big N Auditor Change</i> $_{[t-2,t-1]}$	0.13	975	0.14	15096	-0.00	[0.66]
<i>Big N Auditor Change</i> $_{[t-3,t-1]}$	0.17	975	0.18	15096	-0.01	[0.41]

Panel B. *Subsample of licensee firms with big N financial auditor one year prior to entering the contracts*

Variable	Licensee Firms		Compustat Firms		Diff. in means	p -value
	Mean	N	Mean	N		
<i>Financial Auditor Change</i> $_{[t-2,t-1]}$	0.14	696	0.14	10136	-0.00	[0.75]
<i>Financial Auditor Change</i> $_{[t-3,t-1]}$	0.19	696	0.19	10136	-0.00	[0.76]
<i>Big N Auditor Change</i> $_{[t-2,t-1]}$	0.09	696	0.12	10136	-0.03*	[0.02]
<i>Big N Auditor Change</i> $_{[t-3,t-1]}$	0.13	696	0.15	10136	-0.03*	[0.03]

Table 1.8. Bargaining Power

This table presents results from my analysis of audit terms after explicitly controlling for bargaining power. The dependent variables in Panels A are *Length of Auditable Periods* and *Unrestricted Audit*. The dependent variables in Panel B are *Audit Fee Penalties* and *Interest Penalties*. Columns (1) through (4) in each Panel include industry fixed effects. *Bargaining Power* takes a value of zero if the licensor is a non-corporate entity (e.g., research institute, universities) without manufacturing capacities, or a privately-held company; one if the asset size difference between the licensor and licensee is below the median; and two if the asset size difference between the licensor and licensee is above the median. Control variables include *Licensor's tech support*, *Material to Licensee*, *Royalty %*, *Licensee Volatility*, and *Licensee Product Market Fluidity*. For parsimony, I do not tabulate coefficients on control variables. Standard errors are heteroscedasticity robust, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All variables are defined in Appendix 1.A.

Panel A. Audit scope analysis

Variable	Predicted	Audit Scope			
		Length of Auditable Period	Length of Auditable Period	Unrestricted Audit	Unrestricted Audit
<i>Bargaining Power</i>		-0.0828 (0.0528)	-0.0904* (0.0525)	-0.0657*** (0.0198)	-0.0682*** (0.0198)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	+	0.204** (0.0960)		0.0721** (0.0358)	
<i>Industry Non-Specialist Financial Auditor</i>	+		0.357*** (0.116)		0.0708* (0.0408)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	-	-0.173*** (0.0312)	-0.173*** (0.0311)	-0.0603*** (0.0118)	-0.0605*** (0.0117)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	-	0.116 (0.148)	0.125 (0.146)	0.0231 (0.0547)	0.0252 (0.0545)
<i>Duration until Patent Expiration</i>	-	-0.195** (0.0893)	-0.207** (0.0885)	-0.0614* (0.0333)	-0.0632* (0.0332)
<i>Excl. License</i>	-	-0.0301 (0.0945)	-0.0438 (0.0943)	-0.152*** (0.0343)	-0.156*** (0.0343)
Controls		YES	YES	YES	YES
Industry FE		YES	YES	YES	YES
Observations		975	975	975	975
R-squared		0.102	0.107	0.178	0.177

Table 1.8: Panel B. Penalty analysis

Variable	Predic- ted	<i>Penalties</i>			
		Audit Fee Penalties	Audit Fee Penalties	Interest Penalties	Interest Penalties
<i>Bargaining Power</i>		0.0215 (0.0188)	0.0202 (0.0190)	0.0419** (0.0193)	0.0428** (0.0191)
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	-	0.0476 (0.0341)		-0.0165 (0.0330)	
<i>Industry Non-Specialist Financial Auditor</i>	-		-0.0745* (0.0408)		-0.125*** (0.0423)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	+	0.102*** (0.0113)	0.101*** (0.0113)	0.0489*** (0.0108)	0.0482*** (0.0109)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	?	0.182*** (0.0575)	0.181*** (0.0586)	0.0838* (0.0484)	0.0811* (0.0491)
<i>Duration until Patent Expiration</i>	?	0.0477 (0.0338)	0.0520 (0.0338)	-0.000490 (0.0307)	0.00480 (0.0309)
<i>Excl. License</i>	?	0.141*** (0.0345)	0.138*** (0.0344)	0.0700** (0.0342)	0.0716** (0.0340)
Controls		YES	YES	YES	YES
Industry FE		YES	YES	YES	YES
Observations		975	975	975	975
R-squared		0.167	0.168	0.099	0.108

CHAPTER 2. Implicit Corporate Taxes and Technology Transfer

(Joint work with Jennifer Blouin)

2.1. Introduction

This paper investigates whether royalty rates bear implicit taxes. Using a sample of royalty agreements between unrelated parties, we document that royalty rates are influenced by the explicit tax rates of the parties' jurisdictions. Our preliminary results, however, provide limited evidence that the tax influences on royalties are related to the underlying supply of the licensed technology.

The theory of implicit taxes suggests that the after-tax returns of similarly risky assets should converge. In a corporate setting, firms will invest in more tax-favored projects, increasing the demand and, therefore, the price of inputs. In turn, the increase in supply (created by the increase in investment in the tax-favored project) drives down the pre-tax returns on the project. Absent frictions, as explicit taxes decrease, implicit taxes should increase and offset the explicit tax savings. The inter-play of these economic forces is determined, however, by the extent of market competition in the industry. If the supply of the output is inelastic, as would be the case with unique intellectual property, then the price of the output will appear to be more sensitive to taxes.

While we have a body of evidence consistent with the presence of implicit taxes in the pricing of financial assets (e.g., Lang and Shackelford, 2000; Guenther, 2000; Guenther, 1994), work on the role of implicit taxes in corporate activity is relatively

sparse.³³ Typically, papers investigating corporate implicit taxes investigate whether corporate pre-tax returns are associated with corporate tax burdens (e.g., Wilkie, 1992; Jennings et al., 2012; Markle et al., 2017). These papers are essentially indirectly inferring the role of corporate taxes on the firms' production function. Since the specific pricing of inputs and outputs is generally unobservable, researchers look to aggregate pre-tax performance to investigate tax effects. A notable exception is Shackelford (1991) who is able to identify the pricing implications of corporate tax changes on banks' loans to employee stock ownership plans. Like Shackelford (1991), we are able to investigate whether a specific firm contract is affected by tax incentives – license agreements for the use of propriety intellectual property.

Using our sample of 2,291 royalty agreements between 2,165 unique licensor-licensee pairs, we document a statistically significant association between royalty rates and state-level corporate taxes faced by the licensor. This finding suggests that licensors consider their tax burden when setting royalty rates. In effect, we find that licensees bear the incidence of the licensors' explicit tax.

Our results also suggest that a licensor with unique IP is able to charge a higher royalty rate than a licensor with a more standard or usual IP consistent with the unique IP being more valuable. However, our preliminary evidence does not suggest that the unique IP creates sufficient licensor market power to explain variation in IP-based implicit taxes. This result is somewhat puzzling and suggests that our results could be explained by risk. In the future, we intend to undertake additional analyses where we use different tax-types

³³ There are many papers that find evidence of corporate tax incidence in financial assets (e.g., Plesko, 2005; Engel et al., 1999; Erickson and Maydew, 1998). But these papers are not studying the role, if any, of implicit taxes on firms' underlying trade or business.

of licensors to act as a control sample to better control for any risk differences in the royalty agreements.

Our paper contributes to the literature by empirically identifying how the interplay between bargaining power and tax incentives is associated with the degree of passing implicit taxes onto customers. While prior papers attempt to infer the role of implicit corporate taxes in the firms' production (e.g., Wilkie, 1992; Jennings et al., 2012; Markle et al., 2017), these papers are limited in identifying the specific pricing of inputs and outputs, due to data limitations. In contrast, our setting allows us to observe royalty rates as the specific pricing terms, and specific characteristics of underlying IP to proxy for bargaining power. Furthermore, we observe exact locations of contracting entities (e.g., subsidiary), as opposed to headquarters of the parent companies, and obtain a clean identification of the tax effects on these inter-firm transactions. To our best knowledge, this paper is the first paper to document the large sample evidence of corporate implicit taxes.

We contribute to the incidence debate. As noted by Whalley (1997, p. 1), "the question of the incidence of the corporate tax is not well-defined, and should be approached with a certain amount of skepticism". To date, this ambiguity has not been clarified as the recent literature, with papers such as Auerbach (2005) and Fuest (2014), indicating that existing theoretical and empirical analyses are unable to provide unambiguous or widely accepted answers to the corporate income tax incidence issue. By documenting that contract prices are sensitive to corporate taxes, we provide evidence that customers bear some incidence of corporate taxation.

2.2. Background and Predictions

2.2.1. Basic Theory

Miller (1977) implies that after-tax returns are identical across all assets, assuming constant risk and the absence of market frictions. Scholes and Wolfson (1992) defines an implicit tax as a reduction in the pretax rate of return attributable to a lower explicit tax on an investment. The classic setting for illustrating an implicit tax mechanism is the US bond market, where investors choose between a tax-exempt bond and a fully taxable Treasury security of identical risk. As more high-rate investors purchase the tax-favored bond, increased demand raises the price of the tax-exempt bond and drives down the effective interest rate (the pretax rate of return). The investors thus “pay” implicit tax by accepting a lower pretax return on the tax-favored bond. In equilibrium, the marginal investor achieves the same after-tax return with either investment.

Moving to a corporate setting, the equilibrium role of corporate taxes on pre-tax returns is less obvious. Typically, general equilibrium models of savings, portfolio composition and capital allocation find that the optimal corporate tax rate in an open economy is zero (e.g., Gordon (1986)). These models then provide evidence that capital allocation is solely a function of personal-level taxes. If corporate taxes are increased from zero, then these models’ baseline prediction is a reduction in capital investment which, in turn, leads to drop in supply and an increase in the average (and marginal) returns to production.

A related line of theory results in predictions regarding the “incidence” of corporate taxes. While the general equilibrium models suggest a trade-off between taxes and capital investment, the incidence models suggest that taxes could influence other corporate activity. The incidence of the corporate tax is defined as its effect on the level and

distribution of real income over time. The legal incidence refers to the immediate impact of a tax, while the economic incidence refers to the shifting of the tax to some other party. For example, typically, the incidence of the corporate tax is argued to fall on consumers (via higher prices), capital providers (through lower returns on their investments), suppliers and/or labor (through lower prices or wages, respectively). Consider that the legal incidence is akin to an explicit tax and the economic incidence is akin to an implicit tax.

Work on the incidence of corporate taxes has its foundation in papers such as Harberger (1962) and Krzyzaniak and Musgrave (1963, 1966). Harberger's (1962) theoretical analysis suggests that the corporate tax has the effect of reducing the after-tax return to capital invested in the corporate section. This, in turn, reduces the flow of capital into corporate investments, leading to a rise in the required pre-tax rate of returns relative to non-corporate investment. Ultimately, his work suggests that the economic incidence of the corporate tax depends on the relative factor intensities (between the corporate and non-corporate sectors), the elasticity of substitution between capital and labor, and the elasticity of substitution of demand for each sector's products. Interestingly, Harberger's model does not provide any estimated magnitudes of incidence between consumers, shareholders/bondholders, suppliers or employees. Rather, it is his numerical simulations in the back of his paper that suggests that capital providers bear the full incidence of the corporate tax.

There are a myriad of papers since Harberger's seminal study that attempt to identify the party that bears the incidence of the corporate tax. These papers find wildly varying results. As mentioned, some argue that capital bears the entire tax (e.g., Harberger 1962). Others' work implies that labor bears a disproportionate amount of the corporate tax (e.g., Liu and Altshuler 2013; Fuest et al 2013; Carroll 2009).

Notice that the empirical work studying implicit taxes is effectively based on the premise that shareholders do not bear 100% of the corporate tax burden. If equity capital bore the entire corporate tax burden, then increases in corporate taxes would simply reduce firms' pre-tax returns. Findings that suggest a positive association between pre-tax performance and tax burdens can only hold if at least some of the corporate tax burden is born by suppliers, customers and/or labor. Hence, evidence of implicit taxes provides insight about the incidence of the corporate tax burden.

2.2.2. Empirical Literature

There is an extensive literature providing evidence of implicit taxes by studying associations between *investor-level* taxes and pre-tax returns. A major challenge in this research is the difficulty in separating the effects of taxes on security prices from the effects of differences in risk. Most studies that succeed in cleanly identifying implicit taxes at the investor level use exogenous shocks to explicit tax rates on specific investments. Guenther (1994) provides evidence of economically substantial responses in U.S. Treasury bond prices to tax rate changes in 1981 and 1986, and Lang and Shackelford (2000) finds that non-dividend-paying stocks' prices increased at the surprise announcement of a 1997 investor-level capital gains tax rate reduction. Erickson and Maydew (1998) use the announcement of a proposed change in the dividends received deduction (DRD) from 70% to 50% to identify implicit taxes on preferred shares. Edwards and Shevlin (2011) and Klassen and Mescall (2012) document that the Canadian government's announcement on the end of flow-through treatment of income trusts (an effective increase in explicit taxes) resulted in a significant stock price decline.

Several studies investigate *corporate-level* implicit tax effects, arguing that if implicit taxes are present, explicit tax savings will be associated with lower pretax rates of

return. Wilkie (1992) was the first paper to use firm-level data to find that pretax return on equity is decreasing in tax subsidies, consistent with the expectation that implicit taxes reduce the returns of the subsidized firms. Jennings Weaver, and Mayew (2012) and Chyz, Luna, and Smith (2017) both effectively extend Wilkie (1992) to find that reductions in explicit corporate tax rates appear to have been replaced by implicit corporate tax rates. Markle, Mills and Williams (2017) suggests that this implicit v. explicit tax trade-off can be explained by transfer pricing activity by US multinational firms.

Berger (1993) studies the explicit and implicit tax effects of the Research and Experimentation (R&E) credit in the U.S. By documenting a stock price decline around the legislation create the R&E tax credit, he infers that the market expects firms bear implicit taxes as research activities become more expensive. Although the market reacts negatively to the passage of the tax credit, his analysis still implies that the credit results in a very significant increase in R&E activity.

While each of the above studies finds evidence of the role of corporate taxes on a measure of pre-tax performance, none of the papers documents the specific mechanism by which the tax burden is shifted to other parties. As far as we are aware, Shackelford (1991) is the only paper that is able to document how changes in corporate taxes affects firms' dealings with their customers. In particular, Shackelford (1991) capitalizes on financial institutions' lending to employee stock ownership plans (ESOPs). The Tax Reform Act of 1984 specifies that banks who lend to ESOPs may exclude half of the interest income received on loans to ESOPs from their taxable income. Because the benefits of interest exclusion are uncertain, most ESOP loans provided a form of tax indemnification. Specifically, two interest rates were provided in an ESOP loan agreement. The first assumes that the exclusion is available to the lender and the second assumes that the loan's interest is fully taxable. Since the ESOP loans provides two interest rates

for the same loan from the same lender to the same borrower, differing only in their tax treatment, they provide an ideal setting to investigate the presence of implicit taxes. Shackelford (1991) ultimately documents that the interest rates assuming no interest deductibility are substantially higher than the interest rates assuming only partial taxability. Given the difference in interest rates, he finds that roughly 75 percent of the tax benefits from the exclusion are passed onto the borrower (i.e., the ESOP).

2.2.3. Hypotheses

We add to the corporate-level implicit tax literature by studying a unique group of corporate contracts – license agreements for intellectual property. Our sample of license agreements contains contracts written between unrelated-third parties. As such, these agreements' pricing should be set based on arms-length negotiations. In addition to the type of technology being licensed, these contracts include information about the licensee and the licensor including their location. Our sample of agreements includes licensors operating in a variety of states as well as some based outside of the U.S. This information provides variation in corporate tax burdens that we can use to test for the presence of implicit taxes. This leads to our first hypothesis:

Hypothesis 1: The royalty rate set in the license agreement is positively associated with the licensor's corporate tax rate.

Since the majority of the benefit of the interest exclusion is passed onto the borrower, Shackelford's (1991) results also suggest that ESOP lending is a fairly competitive market. Consistent with competition affecting implicit taxes, Salvador and Vendrzyk (2006) examine the effect of market power to reduce implicit taxes using a sample of 60 U.S. defense contractors. Since the defense industry is dominated by a

handful of firms, they conjectured that these contractors may bear lower implicit taxes (i.e., they pass more of their tax burden to their customers). These authors investigate whether the Tax Reform Act of 1986's reduction in corporate tax preferences affect measures of defense firms' pre-tax performance. Ultimately, they find a negative relation between the explicit rate increase and changes in financial statement and market measures of pretax returns, consistent with the presence of implicit taxes. These results suggest that even firms in a relatively non-competitive industry did not have sufficient market power to escape implicit taxes.

As we have information about the licensed IP, we can infer the relative market power of the licensor. If the IP is particularly unique (i.e., difficult to be replaced), then we assume that the licensor has a greater bargaining power to set the royalty rate to incorporate its corporate tax burden. This leads to our second hypothesis:

Hypothesis 2: The positive association between the licensor's corporate tax rate and the agreement's royalty rate is increasing in the uniqueness of the licensor's IP.

Said another way, we anticipate that evidence of implicit taxes will be stronger in contracts pertaining to more unique IP relative to more standard or "usual" technology.

In addition to investigating the role of the licensor's taxes on royalty rates, our data also provides an opportunity to observe whether the licensees' tax rates affect the royalty rate negotiation. To the extent that the licensee is a price-taker for the licensed IP (due to its uniqueness), the licensee's tax rate should not affect the price set in the contract. However, if the licensee represents an organization comprised of affiliates in multiple jurisdictions, *ceteris paribus*, the licensee would prefer to make the royalty payment from one of its high tax affiliates as this maximizes the firm's after-tax cash flows. This finding suggests that royalty rates may be negatively associated with the spread between the licensor and licensee tax rates.

Relatedly, if a licensor is the price-taker (because the licensed IP is considered standard), then a multi-jurisdictional licensor would prefer to receive the royalty payment in a lower tax jurisdiction. This behavior would maximize the licensor's after-tax cash flows. We assume, again, that the licensee would still maximize its after-tax cash flows by paying the royalty from a high tax jurisdiction. These behaviors suggests a positive association between the royalty rates and spread between the licensor and licensee tax rates.

Both of these predictions imply that the spread will be associated with royalty rates. This insight leads to our final set of hypotheses:

Hypothesis 3: The spread between the licensor and licensee tax rates is associated with royalty rates.

Hypothesis 3a: If the IP underlying the royalty agreement is unique, the spread between the licensor and licensee tax rates is negatively associated with royalty rates.

Hypothesis 3b: If the IP underlying the royalty agreement is not unique, the spread between the licensor and licensee tax rates is positively associated with royalty rates.

Notice that neither of these last two predictions imply that the counter-parties' tax rate will affect the royalty rate. Instead, these predictions involve the likelihood of the counter-parties to be located in high or low tax jurisdictions.

2.3. Data selection, variables of interest and descriptive statistics

2.3.1. Sample selection and composition

We use data from KtMine's License Agreement database, which contains material royalty agreements and documents from SEC filings.³⁴ Licensing agreements are most

³⁴ The year 1996 was the first year that the SEC required firms to file electronically. Regulation S-K of the Securities Act of 1933 requires publicly filing companies to include all material contracts

often included in Exhibit 10 attached in a 10-Q or 10-K filing. We rely upon KtMine's coding of basic facts about each agreement including the licensor, licensee, agreement type, royalty rates, licensed territories, and exclusivity provisions. We hand-collect other contract characteristics and obtain financial information from Compustat. Country-level statutory rate data comes from the OECD (<http://www.oecd.org/tax/tax-policy/tax-database.htm>) and US state-level tax rates are from Tax Foundation (<https://taxfoundation.org/>). Appendix 2.A defines all our variables.

We require a license contract to have non-missing (i.e., non-redacted) royalty rates and addresses of the contracting parties written out in the contract. We use local addresses, rather than headquarter addresses, of the contracting licensors and licensees because royalty revenues (expenses) will be taxed at the subsidiary-level where the contracting entities are based in. We do not necessarily restrict the contracting entities to be publicly-traded entities with available financial data. This leads to a total of 2,291 licensing contracts with licensors located in 34 different countries and licensees located in 36 different countries.

Table 2.1 describes the sample composition. Panel A describes the countries of sample licensors and licensees. Given that the contracts are retrieved from SEC filings, 1,861 (1,865) licensors (licensees) in the sample of 2,291 contracts are based in the United States (U.S.). Panel B describes the U.S. states of licensors and licensees that are based in the U.S. The distributions across the U.S. states are broadly similar for the samples of licensors and licensees. California, Massachusetts, New York, New Jersey, and Texas are most represented in the licensor sample, and California, New York,

as exhibits in SEC filings. Material contracts must be attached to the S-1, S-4, S-11, F-1, F-4, 10-Q, 10-K or 8-K for the corresponding period in which the contract is executed.

Massachusetts, Florida, and New Jersey are most represented in the licensee sample. Panel C presents the licensors' types. Of 2,291 licensors, there are 1,805 companies, 25 government agencies (e.g., National Aeronautics and Space Administration), 175 individuals (i.e., inventors), 53 research institutes³⁵ (e.g., American Dental Association Health Foundation), and 233 universities (e.g., Massachusetts Institute of Technology). Since most of the not-for-profit licensee agreements may be exempt (e.g., McDowell, 2008³⁶), we either include a control variable for for-profit licensors (i.e., company-type licensors) or exclude not-for-profit licensors in our analysis.

2.3.2. *Descriptive Stats*

Table 2.2 tabulates the industry distribution of our sample contracts.³⁷ Panel A describes the sample of 2,291 filing firms by Fama-French 12 industry classification. The Healthcare, Medical Equipment, and Drugs (832 contracts) industry is most represented according to the filing companies' Fama-French 12 industry classification. Similarly, Healthcare, the Medical Equipment, and Drugs industry is most represented among the licensors and licensees where their industry membership information is available (See Panels B and C).³⁸ Panel D reports the filing firms' Fama-French 48 industry membership. Among 832 contracts in the Healthcare, Medical Equipment, and Drugs (Panel A), there are 15 contracts in Healthcare, 167 contracts in Medical Equipment, and 650 contracts in Pharmaceutical Products (650 contract) according to the Fama-French 48 industry classification (Panel D). In the main analysis, we use licensors in the Pharmaceutical

³⁵We do not include universities as "research institutes" and identify universities as a separate category.

³⁶ <https://www.stepto.com/images/content/1/3/v1/135/3446.pdf>

³⁷ I report the industry classification of filing companies.

³⁸ Licensors' and licensees' industry membership information is available only if they are publicly-traded companies with available data in Compustat. We only have 442 licensors and 597 licensees with available financial and industry data.

Products industry as a proxy for price setters because pharmaceutical patents, by design, allows the licensors to enjoy greater legal protection and exposed to lower risk of technology replacement. These features, in turn, increase the licensors' greater bargaining power and likelihood of setting the price. In our sample, there are 28.4% of sample contracts with "price-setter" licensors (i.e., 650 contracts out of 2,291 contracts).

Table 2.3 describes the variables used in our empirical tests. Panel A reports the summary statistics of tax rates, royalty rates, and other characteristics. The average statutory tax rates are 34.7% and 34.6% for the licensors and licensees, respectively, while the median is 35% for both licensors and licensees. Among the US-based licensors and licensees, the average state tax rates are 7.28% and 7.20% for the US licensors and licensees, respectively. The median state-level tax rates for US licensors and licensees are 7.50%. With respect to the firm size, the average asset size of publicly-traded licensors is \$4.0 billion, while the average asset size of publicly-traded licensees is \$3.25 billion.³⁹ The mean royalty rate is 10.9% with the median value of 5 %. Sixty-nine percent of the sample contracts are worldwide licenses where the licensor grants the licensee the right to sell the licensed products worldwide. Ninety-two percent of the sample contracts are exclusive contracts.

Panels B and C report the royalty rates by industry classification. The lowest mean royalty rates are reported in the Consumer Non-Durables Goods industry, while the highest mean royalty rates are in the Healthcare, Medical Equipment, and Drugs industry. This contrast is consistent with Cohen, Nelson, and Walsh (2000)⁴⁰ who find that patents

³⁹ We only report the asset sizes of 442 licensors and 597 licensees whose financial information is available on Compustat.

⁴⁰ Cohen, Wesley M., Richard R. Nelson, and John P. Walsh. Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not). No. w7552. National Bureau of Economic Research, 2000.

are effective means of protecting intellectual assets in the medical equipment and drugs industries, while trade secrecy is the most effective mechanism in the food, textiles, paper (i.e., consumer non-durable goods) industries. As patents protect intellectual properties more effectively, the licensors are able to charge higher rates to their licensees. Within the Healthcare, Medical Equipment, and Drugs industries, license agreements in the Pharmaceutical Products industry charges the highest mean royalty rate of 11.98% (See Panel C of Table 2.3).

2.3.3. Univariate Analysis

As discussed in Section 2, the theory of implicit taxes suggests a positive association between pre-tax rates of return and tax rates. We test for implicit taxes by studying the association between corporate tax rates and royalty rates. We begin by partitioning our analysis based on domestic and foreign licensees and licensors. Tables 2.4 and 5 present univariate analysis. We first divide our sample into four subsamples based on whether the licensor and/or licensee are based in the US (See Figure 1). Using the subsamples, we compare the cross-sectional differences in mean values of the variables used in the analysis.

		LICENSOR	
		US	Non-US
LICENSEE	US	[1]	[3]
	Non-US	[2]	[4]

Figure 1. Subgroups of licensor-licensee pairs

2.3.3.1. Univariate Analysis: Firm size and contract characteristics

Table 2.4 reports cross-sectional differences in mean values of the independent variables used in the main regression. We do not have directional predictions on the cross-

sectional differences of these characteristics and present the results for descriptive purposes. Panel A presents the differences between the subsamples [1] and [3]. When contracting with US licensees, licensors tend to be bigger in asset sizes if the licensors are based in the US. However, there is no meaningful difference in asset sizes of the US licensees between subsamples [1] and [3]. The US licensor & US licensee sample (subsampling [1]) is more likely to agree on worldwide licenses than the non-US licensor & US licensee sample (subsampling [3]). There is no significant difference in the likelihood of contracting on exclusive contracts between these two subsamples.

Panel B of Table 2.4 presents the differences between the subsamples [1] and [2]. When contracting with US licensors, non-US licensees tend to be bigger in asset sizes than US-based licensees. However, there is no meaningful difference in licensee asset sizes nor the likelihood of worldwide license between subsamples [1] and [2]. The US licensor & US licensee sample (subsampling [1]) is less likely to agree on worldwide licenses than the US licensor-non-US licensee sample (subsampling [2]).

Panel C of Table 2.4 presents the differences between the subsamples [2] and [4]. Between the two subsamples, licensees tend to be bigger in asset sizes when they contract with US-based licensors. Non-US licensors tend to be larger in asset sizes than US licensors. However, there is no meaningful difference in the likelihood of worldwide license nor exclusive contracts between subsamples [2] and [4].

2.3.3.2. Univariate Analysis: Royalty rates

Table 2.5 reports cross-sectional differences in mean royalty rates among the four subsamples. Given that firms are subject to high statutory tax rates, we expect US licensors demand higher royalty rates if implicit taxes exist (i.e., Royalty [1] > Royalty [3], and Royalty [2] > Royalty [4]).

Panel A presents the differences in royalty rates between the four subsamples. Consistent with hypothesis 1, the royalty rates are significantly (and statistically) greater for subsample [1] than subsample [3]. However, we do not find results consistent with our prediction for subsamples [2] versus [4].

Panel B replicates the analysis in Panel A among the subsample of taxable licensors only. Given that not-for-profit licensors may be tax exempt on their royalty revenues, we exclude not-for-profit licensors. The results are consistent with those reported in Panel A. Again, we do not find results consistent with our prediction for subsamples [2] versus [4].

Next, we use the variation in corporate state income taxes to find evidence of implicit taxes. In Table 2.6, we limit our analysis to only US licensor-US licensee pairs to investigate whether the cross-sectional differences in royalty rates are associated with US state-level tax rates. Once again, we partition the US licensor-US licensee sample into subsamples based on their tax burden. Here, we assume that licensors and licensees with state tax rates above (below) the median have relatively high (low) tax burdens. Using the subsamples, we compare the cross-sectional differences in mean royalty rates.

		<i>LICENSOR US state tax rate</i>	
		Above Median	Below Median
<i>LICENSEE state tax rate</i>	Above Median	[5]	[7]
	Below Median	[6]	[8]

Figure 2. Subgroups of US licensor-US licensee pairs

Given that firms are subject to high statutory tax rates, we expect high-state tax rate licensors demand higher royalty rates if implicit taxes exist (i.e., Royalty [5] > Royalty [7], and Royalty [6] > Royalty [8]).

Table 2.6 Panel A presents the differences in royalty rates between the four subsamples. Once again, we find moderate evidence consistent with hypothesis 1. The royalty rates are not significantly different between subsample [5] and subsample [7]. But we do find that royalty rates are significantly (and statistically) greater for subsample [6] relative to subsample [8].

2.3.3.3. Univariate Analysis: Royalty rates and Differences in Licensor and Licensee Tax Rates

Next, we investigate whether royalty rates influence the spread between licensor and licensee tax rates. Because our sample is primarily composed of US entities, we rely on the spread in state tax rates to undertake these tests. Recall that Hypothesis 3 predicts that the spread between the licensor and licensee tax rates should be associated with royalty rates. But the direction of this association depends upon whether the licensor is a price-setter (Hypothesis 3a) or a price-taker (Hypothesis 3b). Since we failed to find any evidence that the uniqueness of the IP influences implicit taxes, here we report a simple univariate comparison of the spread in tax rates between the licensor and licensee and royalty rates. In the presence of implicit taxes, we anticipate that higher royalty rates (suggesting licensors in high-tax jurisdictions) would be associated with smaller spreads between licensor and licensee tax rates (subsample [9] > subsample [10]). Recall that higher royalty rates would cost a licensee less if paid from a high-tax jurisdiction.

Licensor state tax rate <(=)Licensee state tax rates	Licensor state tax rate > Licensee state tax rates
[9]	[10]

Figure 3. Subgroups of US licensor-US licensee pairs

In an untabulated analysis, we find that royalty rates are statistically larger for subsample [10] as compared to subsample [9]. This is a puzzling result that could be

explained by risk differences across the samples. In future tests, we plan to revisit this analysis and partition the sample by the relative uniqueness of the royalty agreement's IP.

2.4. Research Design and Results

2.4.1. Association between tax incentives and royalty rates

To test whether differential tax rates between the licensor and licensee affect the royalty rates, we estimate the following equation using ordinary least squares (OLS):

$$\begin{aligned} \text{Royalty}\% = & \alpha + \beta_1 \text{TaxRate} + \beta_2 \text{ForProfitLicensor} + \beta_3 \text{PriceSetter} \\ & + \sum \beta_n \text{CONTROL}_n + \epsilon \end{aligned} \quad (2.4)$$

where *TaxRate* is either the licensor's country-level or state-level corporate tax rate. All variables are defined in Appendix 2.A.

An estimate of $\beta_1 > 0$ would be consistent with our prediction that implicit taxes increase pretax royalty rates.

We control for whether the licensors are for-profit entities (i.e., companies) and whether they are price-setters or price-takers.⁴¹ We expect $\beta_2 > 0$ because for-profit licensors face greater tax burden and are more likely to demand greater pre-tax returns from royalty revenues than not-for-profit licensors. We also predict $\beta_3 > 0$ given that licensors with greater bargaining power (e.g., price-setter licensors) can charge higher royalty rates than licensors with lower bargaining power (e.g., price-taker licensors). In addition, we control for contract characteristics (i.e., worldwide and exclusive licenses), and licensor and licensee firm size, where the data is available.

⁴¹ As discussed in Section 3.2, we use licensors (not) in the Pharmaceutical Products industry as a proxy for "price-setter" ("price-taker") licensors.

2.4.2. Results

Table 2.7 Panel A reports our results from estimating equation (2.1) when tax incentives are measured by licensors' country-level tax rates. Licensors' country-level tax rates have no significant effect on royalty rates. This could be for one of two reasons. First, our sample includes non-taxable entities such as universities and governmental agencies. The inclusion of these firms could add noise to our analysis. Second, as described above, the majority of our sample is composed of US licensor-US licensee contracts (1,608 contracts out of 2,291 contracts) where there is no difference in the licensors' and licensees' country-level statutory rates.

Consistent with for-profit, taxable licensors demanding greater pre-tax returns on licensing than not-for-profit licensors, we find the for-profit licensors charge higher royalty rates. We also find licensors who are price setters (i.e., are in the pharmaceutical industry) charge higher royalty rates. These results are consistent with the notion that licensors with greater bargaining power are able to charge higher royalty rates. In addition, the coefficients on *Worldwide license* and *Exclusive license* are positive and statistically significant. These results are consistent with prior literature that licensees are willing to pay higher prices to contracts covering greater geographic regions and/or guaranteeing exclusive market positions.

In Table 2.7 Panel B, we use a subsample of for-profit (taxable) licensors and report our results from estimating equation (2.1) when tax incentives are measured by licensors' country-level tax rates. We find licensors' country-level tax rates have insignificant impact on the royalty rates. Consistent with licensors with greater bargaining power being able to set higher royalty rates, the coefficients *Price Setter* are positive and statistically significant. We find qualitatively similar results when industry fixed effects are

included (See Table 2.7 Panel C). The industry fixed effects mitigate the effects of systematic differences in royalty rates across different industries.

Table 2.8 Panel A reports our results from estimating equation (2.1) using licensors' US state-level tax rates as the measure for tax incentives. We find that licensors' country-level tax rates have positive, significant effect on royalty rates, consistent with our prediction. Given the majority of licensors in our sample is US-based (1,867 contracts out of 2,291 contracts), we find statistically significant results in this specification, compared to our analysis reported in Table 2.7. Similar to our findings in Table 2.7, for-profit, taxable licensors charge higher royalty rates than not-for-tax entities who face lower tax burden, if any. These findings are consistent with licensors with greater tax burdens demanding greater pre-tax returns (royalty rates). The coefficients on *Price Setter* are positive but statistically insignificant.^{42 43}

In Table 2.8 Panel B, we restrict our subsample to for-profit (taxable) licensors based in the US and drop *For-Profit Licensor* from the specification. The dependent variable is measured by licensors' country-level tax rates. We find licensors' country-level tax rates have significant impact on the royalty rates, and the effects are positive, consistent with our prediction. The coefficients *Price Setter* and *Exclusive license* are positive and statistically significant. We find qualitatively similar results when industry fixed effects are included (See Table 2.8 Panel C). The industry fixed effects control for potential systematic industry differences.

⁴² As a falsification test, we run the analysis separately for not-for-profit and for-profit licensors and report results in Appendix B. As expected, we do find insignificant effects of licensors' US state-level tax rates on the royalty rates for the not-for-profit licensor subsamples, while we do find significant, positive impact for the for-profit subsamples.

⁴³ As robustness analysis, we drop 126 contracts where the same licensors-licensees appear more than once ("repeated transactions") in the sample and find consistent results. The results do not seem to be driven by repeated transactors.

2.4.3. Interactive effects of tax incentives and bargaining power

To test whether licensors' bargaining power interacts with licensors' tax incentives, we estimate the following equation using ordinary least squares (OLS):

$$\begin{aligned} \text{Royalty}\% = & \alpha + \beta_1 \text{TaxRate} + \beta_2 \text{TaxRate} \times \text{PriceSetter} \\ & + \beta_3 \text{ForProfitLicensor} + \beta_4 \text{PriceSetter} \\ & + \sum \beta_n \text{CONTROL}_n + \epsilon \end{aligned} \tag{2.2}$$

where *TaxRate* is either the licensor's country-level or state-level corporate tax rate. All variables are defined in Appendix 2.A.

An estimate of $\beta_1 > 0$ would be consistent with our prediction that implicit taxes increase pretax royalty rates. In addition, we expect $\beta_2 > 0$ if bargaining power interacts with the licensors' tax incentives. That is, the positive association between tax rates and pretax royalty rates increases as the licensors' bargaining power increases.

We control for whether the licensors are for-profit entities (i.e., companies) and whether they are price-setters or price-takers.⁴⁴ We expect $\beta_3 > 0$ because for-profit licensors face greater tax burden and are more likely to demand greater pre-tax returns from royalty revenues than not-for-profit licensors. We also predict $\beta_4 > 0$ given that price-setter licensors have greater bargaining power and can demand higher royalty rates than price-taker licensors. In addition, we control for contract characteristics (i.e., worldwide and exclusive licenses), and licensor and licensee firm size, where the data is available.

⁴⁴ We assume licensors in the Pharmaceutical Products industry are most likely to be price setters (i.e., have greater bargaining power because it is difficult and costly to substitute pharmaceutical patents) and use an indicate variable for pharmaceutical licensors as price setters.

2.4.4. Results

Table 2.9 reports our results from estimating equation (2.2) when tax incentives are measured by either licensors' country-level or US state-level tax rates. Licensors' country-level (US state-level) tax rates have no significant effect on royalty rates. *Price Setter* and *For-Profit Licensor* have positive impact on the royalty rates as expected. However, we do not have statistically significant interactive effects of *Licensor tax rate* \times *Price Setter*. In future tests, we plan to revisit this analysis and refine our measure of bargaining power by relative uniqueness of the royalty agreement's IP.

2.5. Conclusions

In this paper, we provide large-sample empirical evidence on implicit tax implications in IP license contracts. We investigate how corporate taxes faces by the licensor affect royalty pricing terms and whether the licensor may pass their tax burden onto their customers given the differentiated nature of underlying IP. Our results suggest that the licensor implicitly factor in their tax burden in royalty pricing, and the licensee, in return, bears the incidence of the licensor's explicit tax. We further show that a licensor with unique IP is able to charge a higher royalty rate than a licensor with a more standard or usual IP, consistent with the unique IP being more valuable. However, our preliminary evidence does not suggest that the unique IP creates sufficient licensor market power to explain variation in IP-based implicit taxes. This result is somewhat puzzling and should be interpreted with caution since our measure of unique IP relies on the relatively rough industry classification. In the future analysis, we intend to refine our measure of unique IP by considering characteristics of licensed patents, as well as including additional controls for heterogeneity across contracts. We also plan to undertake additional analyses where we use different tax-types of licensors to act as a control sample to better control for risk

differences in the underlying IP. Furthermore, we plan to take advantage of exogenous changes in corporate tax burden for causal inferences.

TABLE 2.1. Sample Composition

This table presents the sample composition used in the analysis. Panel A presents the sample composition by licensors' and licensees' countries. Panel B describes the breakdown of licensors' and licensees' US states among the subsample of US-based licensors and licensees. Panel C presents the licensors' types.

Panel A. Licensors' and Licensees' country distribution			
<i>Licensor</i>	N	<i>Licensee</i>	N
ARGENTINA	1	ARGENTINA	3
AUSTRALIA	17	AUSTRALIA	10
AUSTRIA	1	AUSTRIA	1
BAHAMAS	4	BARBADOS	2
BARBADOS	4	BELGIUM	10
BELGIUM	4	BERMUDA	4
BERMUDA	1	BRAZIL	1
BRAZIL	1	CANADA	111
CANADA	118	CAYMAN ISLANDS	2
CAYMAN ISLANDS	1	CHINA	21
CHINA	15	COLOMBIA	1
COLOMBIA	1	COSTA RICA	1
CYPRUS	2	COTE D'IVOIRE	3
DENMARK	7	DENMARK	2
ENGLAND	5	ENGLAND	3
FRANCE	15	FRANCE	6
GERMANY	28	GERMANY	19
HONG KONG	7	GIBRALTAR	1
INDIA	2	HONG KONG	12
INDONESIA	1	INDIA	2
IRELAND	12	IRELAND	11
ISRAEL	31	ISLE OF MAN	1
ITALY	6	ISRAEL	39
JAPAN	29	ITALY	3
LUXEMBOURG	1	JAPAN	40
MALAYSIA	1	LUXEMBOURG	1
NETHERLANDS	7	MALAYSIA	1
NETHERLANDS ANTILLES	1	MEXICO	4
NORWAY	3	NETHERLANDS	6
PANAMA	1	NETHERLANDS ANTILLES	4
PERU	1	OMAN	1
PHILIPPINES	1	PHILIPPINES	1
REPUBLIC OF KOREA	8	POLAND	1
RUSSIA	3	PORTUGAL	1
SINGAPORE	8	REPUBLIC OF KOREA	9
SPAIN	3	SINGAPORE	2
SWEDEN	7	SLOVAKIA	1
SWITZERLAND	30	SOUTH AFRICA	1
TAIWAN	2	SPAIN	3
UNITED KINGDOM	39	SWEDEN	4
USA	1861	SWITZERLAND	32
VIRGIN ISLANDS	1	TAIWAN	7
Total	2291	THAILAND	1
		UNITED KINGDOM	35
		USA	1865
		VIRGIN ISLANDS	2
		Total	2291

TABLE 2.1. Sample Composition (Cont'd)

Panel B: Licensors' and Licensees' US States

<i>Licensor US State</i>	N	<i>Licensee US State</i>	N
AR	5	AL	1
AZ	32	AR	3
CA	462	AZ	25
CO	41	CA	491
CT	34	CO	32
DC	20	CT	41
DE	9	DC	6
FL	103	DE	3
GA	20	FL	141
IA	4	GA	29
ID	2	HI	1
IL	53	IA	7
IN	5	ID	4
KS	8	IL	62
KY	7	IN	3
LA	8	KS	5
MA	158	KY	5
MD	71	LA	7
ME	2	MA	144
MI	21	MD	47
MN	31	ME	11
MO	10	MI	28
NC	36	MN	37
ND	1	MO	23
NE	3	NC	33
NH	6	ND	3
NJ	134	NE	5
NM	16	NH	8
NV	36	NJ	129
NY	149	NM	6
OH	30	NV	35
OK	9	NY	170
OR	11	OH	14
PA	75	OK	2
RI	7	OR	7
SC	9	PA	56
TN	17	RI	15
TX	114	SC	4
UT	33	TN	14
VA	20	TX	95
VT	3	UT	25
WA	34	VA	19
WI	5	WA	54
WV	4	WI	8
WY	3	WV	5
Total	1861	WY	2
		Total	1865

TABLE 2.1. Sample Composition (Cont'd)

Panel C. Licensor Type

Licensor Type	N
Company	1805
Government	25
Individual	175
Research	53
University	233
TOTAL	2291

TABLE 2.2. Industry Breakdown

This table presents the distribution of the sample contracts used in the analysis by industry, using the Fama-French 12 (48) industry classification. Panel A presents the Fama-French 12 industry classification of filing companies. Panel B (C) presents the Fama-French 12 industry classification of publicly-traded licensor (licensee) companies. Panel D presents the Fama-French 48 industry classification of the filing companies.

Panel A. Fama-French 12 Industry of Filing Companies

Industry	N
Consumer NonDurables -- Food, Tobacco, Textiles, Apparel, Leather, Toys	46
Consumer Durables -- Cars, TV's, Furniture, Household Appliances	49
Manufacturing -- Machinery, Trucks, Planes, Off Furn, Paper, Com Printing	86
Oil, Gas, and Coal Extraction and Products	17
Chemicals and Allied Products	47
Business Equipment -- Computers, Software, and Electronic Equipment	281
Telephone and Television Transmission	20
Utilities	1
Wholesale, Retail, and Some Services (Laundries, Repair Shops)	62
Healthcare, Medical Equipment, and Drugs	832
Finance	98
Other -- Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment	752
Total	2291

Panel B. Fama-French 12 Industry of Publicly-Traded Licensors

Industry	N
Consumer NonDurables -- Food, Tobacco, Textiles, Apparel, Leather, Toys	6
Consumer Durables -- Cars, TV's, Furniture, Household Appliances	9
Manufacturing -- Machinery, Trucks, Planes, Off Furn, Paper, Com Printing	24
Oil, Gas, and Coal Extraction and Products	0
Chemicals and Allied Products	6
Business Equipment -- Computers, Software, and Electronic Equipment	63
Telephone and Television Transmission	2
Utilities	0
Wholesale, Retail, and Some Services (Laundries, Repair Shops)	8
Healthcare, Medical Equipment, and Drugs	220
Finance	16
Other -- Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment	88
Total	442

TABLE 2.2. Industry Breakdown (cont'd)*Panel C. Fama-French 12 Industry of Publicly-Traded Licensees*

Industry	N
Consumer NonDurables -- Food, Tobacco, Textiles, Apparel, Leather, Toys	10
Consumer Durables -- Cars, TV's, Furniture, Household Appliances	22
Manufacturing -- Machinery, Trucks, Planes, Off Furn, Paper, Com Printing	18
Oil, Gas, and Coal Extraction and Products	0
Chemicals and Allied Products	11
Business Equipment -- Computers, Software, and Electronic Equipment	85
Telephone and Television Transmission	5
Utilities	0
Wholesale, Retail, and Some Services (Laundries, Repair Shops)	18
Healthcare, Medical Equipment, and Drugs	292
Finance	15
Other -- Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment	121
Total	597

TABLE 2.2. Industry Breakdown (cont'd)
Panel D. Fama-French 48 Industry of Filing Companies

Industry	N
Agriculture	7
Food Products	12
Beer & Liquor	3
Recreation	22
Entertainment	10
Printing and Publishing	2
Consumer Goods	16
Apparel	7
Healthcare	15
Medical Equipment	167
Pharmaceutical Products	650
Chemicals	43
Rubber and Plastic Products	8
Textiles	5
Construction Materials	3
Construction	6
Steel Works Etc	9
Fabricated Products	1
Machinery	28
Electrical Equipment	36
Automobiles and Trucks	15
Shipbuilding, Railroad Equipment	2
Precious Metals	2
Non-Metallic and Industrial Metal	39
Mining	
Coal	1
Petroleum and Natural Gas	16
Utilities	1
Communication	20
Personal Services	18
Business Services	262
Computers	50
Electronic Equipment	62
Measuring and Control Equipment	53
Business Supplies	11
Shipping Containers	4
Wholesale	22
Retail	25
Restaurants, Hotels, Motels	5
Real Estate	8
Trading	85
Other	540
TOTAL	2291

TABLE 2.3. Descriptive statistics

This table presents descriptive statistics for the variables used in the analysis. Panel A presents the summary statistics of all variables. Panel B describes mean and median royalty rates by Fama-French 12 industry of the filing companies. Panel C describes mean and median royalty rates of contracts in the Healthcare, Medical Equipment, and Drugs industries. All variables are as defined in Appendix 2.A.

Panel A. Summary Statistics

VARIABLES	N	mean	sd	p25	p50	p75
<i>Country-level tax rates</i>						
Licensor tax rates	2,291	34.7	4.50	35	35	35
Licensee tax rates	2,291	34.6	4.58	35	35	35
<i>State-level (US only) tax rates</i>						
Licensor tax rates	1,867	7.28	2.36	5.50	7.50	8.84
Licensee tax rates	1,865	7.20	2.43	5.50	7.50	8.84
<i>Royalty rates</i>						
Royalty Rate (%)	2,291	10.9	14.2	3	5	10
<i>Other characteristics</i>						
[Licensor] Assets	442	4,004	14,184	8.19	40.2	292
[Licensee] Assets	597	3,248	9,800	7.37	56.6	429
Worldwide License	2,291	0.69	0.46	0	1	1
Exclusive License	2,291	0.92	0.27	1	1	1

Panel B. Royalty Rates by Fama-French 12 Industry

Royalty rate	N	mean	median
All	2,291	10.90	5
Consumer NonDurables -- Food, Tobacco, Textiles, Apparel, Leather, Toys	46	7.639	4.750
Consumer Durables -- Cars, TV's, Furniture, Household Appliances	49	8.494	5
Manufacturing -- Machinery, Trucks, Planes, Off Furn, Paper, Com Printing	86	8.514	4.125
Oil, Gas, and Coal Extraction and Products	17	10.49	5
Chemicals and Allied Products	47	13.25	6
Business Equipment -- Computers, Software, and Electronic Equipment	281	12.59	6
Telephone and Television Transmission	20	19.05	5
Utilities	1	8	8
Wholesale, Retail, and Some Services (Laundries, Repair Shops)	62	9.955	5
Healthcare, Medical Equipment, and Drugs	832	11.41	5.250
Finance	98	8.040	5
Other -- Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment	752	10.43	5

TABLE 2.3. Descriptive statistics (cont'd)

Panel C. Royalty Rates in the Healthcare, Medical Equipment, and Drugs industries

Royalty rate	N	mean	median
Healthcare, Medical Equipment, and Drugs	832	11.41	5.25
Healthcare	15	8.38	4.0
Medical Equipment	167	9.46	5.0
Pharmaceutical Products	650	11.98	5.5

TABLE 2.4. Univariate Analysis: Firm size and contract characteristics

This table presents cross-sample differences in mean values of the independent variables used in the main regressions. Panel A presents the difference in mean values for the US-licensor firms (subsample [1]) compared to the non-US-licensor firms (subsample [3]) when the licensees are based in the US. Panel B presents the difference in mean values for the US-licensee firms (subsample [1]) versus the non-US-licensee firms (subsample [2]) when the licensors are based in the US. Panel C represents the difference in mean values for the US-licensor firms (subsample [2]) versus the non-US-licensor firms (subsample [4]) when the licensees are not based in the US. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

		LICENSOR	
		US	Non-US
LICENSEE	US	[1]	[3]
	Non-US	[2]	[4]

Panel A. US-licensor firms (subsample [1]) versus non-US-licensor firms (subsample [3])

	[1]		[3]		[1] - [3]
	mean	sd	mean	sd	Difference
[Licensee] Assets	2795.04	9008.31	1173.26	5591.27	1621.78*
[Licensor] Assets	3234.78	11645.09	7672.79	16062.4	-4438.02
Worldwide License	0.71	0.45	0.63	0.48	0.08*
Exclusive License	0.92	0.28	0.91	0.29	0.01
Observations	1608		257		1865

Panel B. US-licensee firms (subsample [1]) versus non-US-licensee firms (subsample [2])

	[1]		[2]		[1] - [2]
	mean	sd	mean	sd	Difference
[Licensee] Assets	2795.04	9008.31	10736.94	16345.91	-7941.90**
[Licensor] Assets	3234.78	11645.09	1845.62	6921.35	1389.15
Worldwide License	0.71	0.45	0.65	0.48	0.06
Exclusive License	0.92	0.28	0.95	0.21	-0.04*
Observations	1608		253		1861

TABLE 2.4. Univariate Analysis: Firm size and contract characteristics (cont'd)*Panel C. US-licensor firms (subsample [2]) versus non-US-licensor firms (subsample [4])*

	[2]		[4]		[2] - [4]
	mean	sd	mean	sd	Difference
[Licensee] Assets	10736.94	16345.91	4618.71	12413.77	6118.23*
[Licensor] Assets	1845.62	6921.35	17204.08	37784.18	-15358.46*
Worldwide License	0.65	0.48	0.64	0.48	0.01
Exclusive License	0.95	0.21	0.94	0.24	0.02
Observations	253		173		426

TABLE 2.5. Univariate Analysis: Royalty rates

This table presents cross-sample differences in mean values of the royalty rates. Panel A presents the difference in mean values for royalty rates among the four different subsamples ([1]-[4]) based on the licensors' and licensees' locations. Panel B presents the difference in mean royalty rates for four different subsamples ([1]-[4]) where the licensors are taxable entities (i.e., companies). ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (one-tail), respectively. p-values (one-tailed) test for differences between means appear in the last column.

		LICENSOR	
		US	Non-US
LICENSEE	US	[1]	[3]
	Non-US	[2]	[4]

- Predictions:
 - Royalty [1] > Royalty [3]
 - Royalty [2] > Royalty [4]

Panel A. Subsamples of licensors and licensees based on their locations

	N1	Mean	sd1	N2	Mean	sd2	Differenc	Probability	
[1]vs[3]	160	10.62	14.13	25	9.319	11.73	1.304*	Pr(Mean1>Mean3)	0.05
[1]vs[2]	160	10.62	14.13	25	12.00	14.30	-1.383*	Pr(Mean1<Mean2)	0.07
[2]vs[4]	253	12.00	14.30	17	14.18	17.10	-2.174	Pr(Mean2>Mean4)	0.91
[3]vs[4]	257	9.319	11.73	17	14.18	17.10	-4.861***	Pr(Mean3<Mean4)	0.00

Panel B. Subsamples of taxable licensors only

	N1	Mean	sd1	N2	Mean	sd2	Differenc	Probability	
[1]vs[3]	135	11.26	14.74	23	9.791	12.07	1.478**	Pr(Mean1>Mean3)	0.04
[1]vs[2]	135	11.26	14.74	24	12.27	14.45	-1.001	Pr(Mean1<Mean2)	0.16
[2]vs[4]	245	12.27	14.45	14	14.76	17.28	-2.498	Pr(Mean2>Mean4)	0.92
[3]vs[4]	236	9.791	12.07	14	14.76	17.28	-4.976***	Pr(Mean3<Mean4)	0.00

TABLE 2.6. Univariate Analysis: Royalty rates among US licensor-licensee pairs

This table presents cross-sample differences in mean values of the royalty rates among US licensor-licensee pairs. Panel A presents the difference in mean values for royalty rates among the four different subsamples ([5]-[8]) based on the licensors' and licensees' locations. Panel B presents the difference in mean royalty rates for four different subsamples ([5]-[8]) where the licensors are taxable entities (i.e., companies). Contracts with median licensors' (licensees') US state tax rates are dropped from the sample. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (one-tail), respectively. p-values (one-tailed) test for differences between means appear in the last column.

		<i>LICENSOR US state tax rate</i>	
		Above Median	Below Median
<i>LICENSEE state tax rate</i>	Above Median	[5]	[7]
	Below Median	[6]	[8]

- Predictions:
 - Royalty [5] > Royalty [7]
 - Royalty [6] > Royalty [8]

Panel A. Subsamples of licensors and licensees above/below median

	N1	Mean	sd1	N2	Mean	sd2	Differenc	Probability	
[5]vs[7]	526	10.40	14.83	19	10.77	14.25	-0.374	Pr(Mean1>Mean3)	0.62
[5]vs[6]	526	10.40	14.83	19	12.24	14.74	-1.846*	Pr(Mean1<Mean2)	0.06
[6]vs[8]	196	12.24	14.74	41	10.09	13.55	2.151**	Pr(Mean2>Mean4)	0.04
[7]vs[8]	192	10.77	14.25	41	10.09	13.55	0.679	Pr(Mean3<Mean4)	0.71

Panel B. Subsamples of taxable licensors only

	N1	Mean	sd1	N2	Mean	sd2	Differenc	Probability	
[5]vs[7]	414	11.54	15.90	14	11.89	15.11	-0.349	Pr(Mean1>Mean3)	0.59
[5]vs[6]	414	11.54	15.90	15	14.24	15.87	-2.695**	Pr(Mean1<Mean2)	0.03
[6]vs[8]	154	14.24	15.87	28	10.82	14.53	3.412**	Pr(Mean2>Mean4)	0.01
[7]vs[8]	148	11.89	15.11	28	10.82	14.53	1.065	Pr(Mean3<Mean4)	0.75

TABLE 2.7. Licensor country-level statutory tax rates and royalty rates

This table presents results from estimating the association between licensors' country-level statutory tax rates and the royalty rates. Panel A reports results using the full sample. Panel B reports results using the subsample of contracts with taxable licensors only, excluding not-for-profit licensors. Panel C reports the subsample of taxable licensors only and includes industry fixed effects (Fama-French 12). All variables are as defined in Appendix 2.A. t-statistics appear in parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

Panel A. Without Industry Fixed Effects

VARIABLES	(1) Royalty%	(2) Royalty%	(3) Royalty%	(4) Royalty%	(5) Royalty%	(6) Royalty%	(7) Royalty%
Licensor statutory tax rate	0.0045 (0.0653)	0.0035 (0.0653)	0.0118 (0.0652)	0.0114 (0.0653)	-0.137 (0.119)	-0.164 (0.145)	-0.143 (0.167)
For-Profit Licensor	4.894*** (0.718)	4.911*** (0.719)	4.821*** (0.718)	4.828*** (0.719)	3.407** (1.451)	6.386 (7.208)	5.259 (8.751)
Price Setter	1.708*** (0.653)	1.689*** (0.654)	1.671** (0.652)	1.664** (0.653)	0.870 (1.140)	1.835 (1.421)	2.068 (1.833)
Worldwide license		0.318 (0.636)		0.125 (0.639)	2.270* (1.263)	3.192** (1.552)	7.097*** (2.119)
Excl. license			3.066*** (1.093)	3.042*** (1.100)	2.926 (2.387)	2.967 (2.679)	6.059 (3.675)
[Licensee] Log of assets					0.364* (0.205)		0.474 (0.307)
[Licensor] Log of assets						0.423* (0.244)	0.435 (0.308)
Constant	6.401*** (2.382)	6.208** (2.413)	3.389 (2.610)	3.337 (2.624)	5.781 (5.124)	3.547 (9.623)	-4.815 (11.46)
Observations	2,291	2,291	2,291	2,291	597	442	279
R-squared	0.022	0.022	0.025	0.026	0.033	0.034	0.077
Industry FE	2,291	2,291	2,291	2,291	597	442	279

TABLE 2.7. Licensor country-level statutory tax rates and royalty rates (cont'd)*Panel B. For-Profit Licensors Only*

VARIABLES	(1) Royalty %	(2) Royalty %	(3) Royalty %	(4) Royalty %	(5) Royalty %	(6) Royalty %	(7) Royalty %
Licensor statutory tax rate	-0.0269 (0.0767)	-0.0256 (0.0768)	-0.0190 (0.0767)	-0.0168 (0.0768)	-0.165 (0.128)	-0.165 (0.146)	-0.151 (0.178)
Price Setter	2.691*** (0.790)	2.706*** (0.792)	2.594*** (0.790)	2.618*** (0.792)	1.932 (1.340)	1.833 (1.434)	-2.272 (3.178)
Worldwide license		-0.220 (0.755)		-0.366 (0.757)	2.210 (1.467)	3.203** (1.564)	7.681*** (2.242)
Excl. license			3.252** (1.352)	3.304** (1.357)	3.549 (2.726)	2.961 (2.690)	5.024 (3.810)
[Licensee] Log of assets					0.371* (0.224)		0.533* (0.312)
[Licensor] Log of assets						0.421* (0.247)	0.567* (0.342)
Constant	12.12*** (2.700)	12.22*** (2.723)	8.856*** (3.018)	8.973*** (3.028)	9.199 (5.614)	9.979 (6.078)	2.181 (8.485)
Observations	1,805	1,805	1,805	1,805	474	438	276
R-squared	0.007	0.007	0.010	0.010	0.025	0.032	0.108
Industry FE	NO						

Panel C. With Industry Fixed Effects & For-Profit Licensors Only

VARIABLES	(1) Royalty %	(2) Royalty %	(3) Royalty %	(4) Royalty %	(5) Royalty %	(6) Royalty %	(7) Royalty %
Licensor statutory tax rate	-0.0387 (0.0769)	-0.0377 (0.0770)	-0.0312 (0.0768)	-0.0291 (0.0769)	-0.154 (0.129)	-0.198 (0.147)	-0.151 (0.178)
Price Setter	4.183*** (1.451)	4.183*** (1.452)	4.178*** (1.449)	4.178*** (1.449)	0.875 (2.249)	-1.332 (2.586)	-2.272 (3.178)
Observations	1,805	1,805	1,805	1,805	474	438	276
R-squared	0.019	0.019	0.023	0.023	0.063	0.069	0.108
Controls (Table 2.7B)	YES						
Industry FE	YES						

TABLE 2.8. Licensor US state tax rates and royalty rates

This table presents results from estimating the association between licensors' US state tax rates and the royalty rates. The sample is restricted to US-based licensors. Panel A reports results using the sample of US-based licensors. Panel B reports results using the subsample of contracts with taxable US-based licensors only, excluding not-for-profit licensors. Panel C reports the subsample of taxable US-based licensors only and includes industry fixed effects (Fama-French 12). All variables are as defined in Appendix 2.A. *t*-statistics appear in parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

Panel A. Without Industry Fixed Effects

VARIABLES	(1) Royalty %	(2) Royalty %	(3) Royalty %	(4) Royalty %	(5) Royalty %	(6) Royalty %	(7) Royalty %
Licensor US state tax rate	0.286** (0.138)	0.280** (0.138)	0.273** (0.138)	0.269* (0.138)	0.157 (0.254)	0.328 (0.310)	0.302 (0.416)
For-Profit Licensor	4.861*** (0.788)	4.877*** (0.788)	4.771*** (0.788)	4.786*** (0.788)	4.159*** (1.581)	6.119 (7.187)	5.352 (9.101)
Price Setter	1.214* (0.727)	1.171 (0.728)	1.183 (0.726)	1.152 (0.728)	0.369 (1.240)	1.183 (1.509)	1.439 (1.993)
Worldwide license		0.698 (0.710)		0.508 (0.714)	2.140 (1.370)	4.178** (1.652)	7.484*** (2.335)
Excl. license			2.903** (1.211)	2.803** (1.219)	3.041 (2.504)	2.724 (2.744)	6.177 (3.936)
[Licensee] Log of assets					0.331 (0.217)		0.310 (0.324)
[Licensor] Log of assets						0.362 (0.268)	0.360 (0.349)
Constant	4.553*** (1.214)	4.102*** (1.297)	2.047 (1.600)	1.806 (1.636)	-0.426 (3.236)	-4.115 (7.757)	-10.61 (9.720)
Observations	1,867	1,867	1,867	1,867	496	392	243
R-squared	0.024	0.024	0.027	0.027	0.037	0.036	0.068
Industry FE	NO						

TABLE 2.8. Licensor US state tax rates and royalty rates (cont'd)*Panel B. For-Profit Licensors Only*

VARIABLES	(1) Royalty %	(2) Royalty %	(3) Royalty %	(4) Royalty %	(5) Royalty %	(6) Royalty %	(7) Royalty %
Licensor US state tax rate	0.367** (0.165)	0.363** (0.166)	0.364** (0.165)	0.362** (0.166)	0.194 (0.297)	0.349 (0.319)	0.327 (0.428)
Price Setter	1.867** (0.891)	1.850** (0.893)	1.749* (0.892)	1.742* (0.894)	0.919 (1.486)	1.118 (1.531)	1.371 (2.018)
Worldwide license		0.262 (0.855)		0.113 (0.857)	2.371 (1.615)	4.153** (1.667)	7.485*** (2.344)
Excl. license			3.186** (1.525)	3.169** (1.531)	4.091 (2.936)	2.737 (2.755)	6.164 (3.953)
[Licensee] Log of assets					0.361 (0.239)		0.310 (0.325)
[Licensor] Log of assets						0.363 (0.271)	0.359 (0.351)
Constant	8.649*** (1.264)	8.495*** (1.360)	5.743*** (1.879)	5.692*** (1.918)	1.943 (3.788)	1.865 (3.617)	-5.403 (5.779)
Observations	1,464	1,464	1,464	1,464	394	388	240
R-squared	0.007	0.007	0.010	0.010	0.020	0.034	0.066
Industry FE	NO						

Panel C. With Industry Fixed Effects & For-Profit Licensors Only

VARIABLES	(1) Royalty %	(2) Royalty %	(3) Royalty %	(4) Royalty %	(5) Royalty %	(6) Royalty %	(7) Royalty %
Licensor US state tax rate	0.368** (0.167)	0.367** (0.167)	0.364** (0.167)	0.364** (0.167)	0.127 (0.304)	0.315 (0.324)	0.335 (0.440)
Price Setter	2.727* (1.564)	2.722* (1.565)	2.674* (1.561)	2.675* (1.562)	0.150 (2.342)	-3.070 (2.762)	-2.513 (3.368)
Observations	1,464	1,464	1,464	1,464	394	388	240
R-squared	0.018	0.018	0.022	0.022	0.064	0.059	0.100
Controls (Table 2.7B)	YES						
Industry FE	YES						

TABLE 2.9. Interaction between licensor tax incentives and bargaining power

This table presents results from estimating Eq (1.2). *Licensor tax rate* is either licensors' country-level statutory rate or US state-level tax rate. All variables are as defined in Appendix 2.A. t-statistics appear in parentheses. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

VARIABLES	(1) Country -level tax rate	(2) Country -level tax rate	(3) Country -level tax rate	(4) Country -level tax rate	(5) US state tax rate	(6) US state tax rate	(7) US state tax rate	(8) US state tax rate
Licensor tax rate	0.0323 (0.0786)	0.0310 (0.0787)	0.0431 (0.0786)	0.0425 (0.0787)	0.250 (0.160)	0.245 (0.160)	0.240 (0.160)	0.236 (0.160)
For-Profit Licensor	4.794 (4.912)	4.738 (4.914)	5.143 (4.906)	5.119 (4.909)	4.850*** (0.789)	4.866*** (0.789)	4.761*** (0.789)	4.776*** (0.789)
Price Setter	4.909*** (0.719)	4.926*** (0.720)	4.838*** (0.718)	4.844*** (0.719)	0.153 (2.518)	0.105 (2.518)	0.179 (2.515)	0.143 (2.515)
Worldwide license		0.312 (0.636)		0.116 (0.639)		0.699 (0.710)		0.509 (0.714)
Excl. license			3.088*** (1.094)	3.066*** (1.101)			2.898** (1.211)	2.798** (1.219)
Licensor tax rate × Price Setter	-0.0896 (0.141)	-0.0885 (0.141)	-0.101 (0.141)	-0.100 (0.141)	0.140 (0.319)	0.141 (0.319)	0.133 (0.318)	0.133 (0.319)
Constant	5.421* (2.840)	5.244* (2.863)	2.265 (3.048)	2.222 (3.058)	4.813*** (1.350)	4.363*** (1.425)	2.298 (1.709)	2.057 (1.742)
Observations	2,291	2,291	2,291	2,291	1,867	1,867	1,867	1,867
R-squared	0.022	0.022	0.026	0.026	0.024	0.025	0.027	0.027
Industry FE	NO	NO	NO	NO	NO	NO	NO	NO

CHAPTER 3. Co-opetition and the Firm's Information Environment

(Joint work with Brian Bushee and Thomas Keusch)

3.1. Introduction

This paper examines how information sharing among competitors affects a firm's information environment. While extensive prior research focuses on the proprietary costs of disclosure due to product market competition, there is limited research on inter-firm information sharing among competitors. This practice, often referred to as "co-opetition," involves firms voluntarily collaborating with competitors in a non-collusive, pro-competitive sense.⁴⁵ A co-opetitive collaboration often comprises a set of agreements among competitors to make joint efforts on activities such as research and development (R&D), production, marketing, distribution, sales, or purchasing. Sharing of proprietary information is an inevitable and important part of these inter-firm collaborations. While the goal of such information sharing is to promote a technology or a market, firms potentially receive an unintended benefit from access to competitor and industry information, which managers can use to enhance their information set and to better predict future sales and earnings growth. We examine these potential benefits by testing whether the initiation of co-opetitive collaborations is associated with changes in management forecast properties—such as forecast frequency and accuracy—and reductions in analyst forecast dispersion.

⁴⁵ The Federal Trade Commission (FTC) and the U.S. Department of Justice (DOJ) have published the guidelines for collaboration among competitors in order to encourage procompetitive collaborations. They acknowledge that "[c]ompetitive forces are driving firms toward complex collaborations to achieve goals such as expanding into foreign markets, funding expensive innovation efforts, and lowering production and other costs. Such collaborations often are not only benign but procompetitive. Indeed, in the last two decades, the federal antitrust agencies have brought relatively few civil cases against competitor collaborations" (FTC and DOJ, 2000).

We examine technology standard setting organizations (SSOs) as our research setting. SSOs are specialized organizations with open memberships that are comprised of firms, scholars, and engineers who strive to develop technology standards. Standardized technologies allow firms to develop products that work together with their competitors' products (e.g., a Samsung Bluetooth speaker can connect to an Apple iPad). By making their products compatible with competitors' products, the firms can take advantage of network effects; i.e., the products' value to the consumer increases with the size of the network of other consumers using the products. Given the increasing importance of technologies and inter-product compatibility, SSOs have become an essential coordination function in technology industries (Farrell and Saloner, 1988; Tushman and Rosenkopf 1992; Garud and Kumaraswamy 1995). SSOs are a powerful setting to study the effects of inter-firm information sharing on the firm's information environment because (1) substantial amounts of proprietary information are exchanged through collaboration at SSOs, (2) the institutional features of SSOs ensure that the information is credible (i.e., firms cannot do "cheap-talk") and (3) participating firms have early access to technical and strategic knowledge that is not readily available to the public.

We obtain a list of 550 firms participating in nine SSOs between 1990 and 2014 from Northwestern's Searle Center on Law, Regulation, and Economic Growth. Each SSO is comprised of a number of working committees that develop standards for certain technology (e.g., the IEEE has an Ethernet Working Group [standard 802.3] and a LAN Working Group [802.11]). Firms can choose how actively they want to participate in the standard setting process. About half of the firms (253) actively contribute to the committees that develop the standards. These "SSO-contributing" firms send their engineers to attend committee meetings and reveal which of the contributing firms' patents are relevant to the standards. The other half (247) are "SSO-passive" firms that never join

any committees and only passively participate in the SSO; e.g., by licensing the developed technology. In our research design, we use the SSO-contributing firms as treatment firms, and use their first year of active committee participation as the treatment year. Then, we use propensity score matching to select control firms among the SSO-passive firms. Thus, all of our sample firms have decided to join SSOs, but differ only in their degree of information sharing with competitors.

We first test whether SSO-contributing firms are more likely to issue management forecasts after initiating active collaboration in their first SSO committee. There are two reasons that active collaboration would increase the likelihood of issuing a forecast. First, prior work finds that firms with high proprietary costs (as proxied by R&D expenditures) are less likely to issue forecasts (Cheng et al. 2005; Wang 2007). Given that SSO-contributing firms are already directly sharing some proprietary information with competitors, they likely face lower incremental proprietary costs in issuing additional public disclosure. Second, prior work finds that earnings predictability is an important factor that drives management forecast issuance (e.g., Waymire 1985; Chen, Matsumoto, and Rajgopal 2011). SSO-contributing firms are able to gather credible information about competitors and markets that complements their firm-specific information set, which should improve the manager's ability to predict sales and earnings. Thus, we predict that the initiation of active committee collaboration will make SSO-contributing firms more likely to issue forecasts.

We test for the effects of SSO information-sharing by examining both sales and earnings forecasts over both annual and quarterly horizons. While each of these forecasts is potentially affected by SSO information transfers, we expect the largest effect to be on sales forecasts and on annual forecasts due to the fact that the standard-setting process most directly affects the sales potential of products over a longer horizon. We find that

SSO-contributing firms are significantly more likely to issue sales forecasts after initiating committee collaboration, especially annual forecasts. There is no effect of committee activity on the decision to issue earnings forecasts. Thus, the results support our prediction that inter-firm information sharing increases the likelihood that managers issue forecasts, but only for annual sales forecasts, suggesting that the competitor information gleaned through SSO collaboration is most useful for resolving uncertainty about product market growth over long horizons.

Next, we predict that SSO-contributing firms will exhibit an improvement in forecast accuracy after initiating active SSO collaboration. Prior work finds that forecast accuracy depends on many factors, such as the firm's complexity; its earnings volatility; the quality of its information system; and the degree to which its earnings are driven by firm-specific factors (versus industry or macroeconomic factors) (see Hirst, Koonce, and Venkataraman 2008 for a review). Prior work also finds that forecasts by one firm affect the information environment of firms in the same industry (Baginski 1987; Han, Wild, and Ramesh 1989; Pyo and Lustgarten 1990; Kim, Lacina, and Park 2008). In our setting, active SSO participation should allow managers to gather more precise information on industry and macroeconomic effects than could be gleaned from public forecasts of competitors. Thus, we predict that SSO-contributing firms will issue more accurate forecasts (i.e., lower absolute forecast errors) after initiating SSO collaboration.

We find that SSO-contributing firms experience a significant improvement in forecast accuracy for annual sales forecasts in the three years after a firm initiates SSO committee collaboration. We also find significant improvements in accuracy for both annual and quarterly earnings forecasts. Thus, while SSO activity does not alter the cost-benefit trade-off enough to encourage more earnings forecast issuances, it does improve the manager's information set enough to significantly reduce forecast error. These results

are consistent with our prediction that actively contributing to SSO committees brings important information benefits to the firm.

Finally, we examine how active SSO participation affects the commonality in the analysts' information sets and, hence, analyst forecast dispersion. Analysts are aware of which firms are participating in SSOs because they often discuss the firm's SSO activity. Prior work finds that analysts obtain additional information from management forecasts (e.g., Baginski and Hassell, 1990; Jennings, 1987; Williams, 1996). For SSO-contributing firms, analysts will expect their management forecasts to be more accurate and credible due to their access to competitor information. Also, analysts can better forecast industry trends if they know which firms are working together through SSOs. Thus, we predict that SSO-contributing firms have lower analyst forecast dispersion than SSO-passive firms after the initiation of active collaboration. We do not find a significant change in analyst sales forecast dispersion for SSO-contributing firms, indicating that analysts do not appear to consistently incorporate the increased frequency and accuracy of managements' annual sales forecasts into their own sales forecasts. However, consistent with our prediction, we do find that SSO-contributing firms exhibit significant reductions in analyst forecast dispersion for both annual and quarterly earnings forecasts after initiating collaboration.

Our findings contribute to the literature by showing that collaborating with competitors in the product market provides an important unintended benefit of improving the manager's information set and the accuracy of management forecasts. Prior work suggests that proprietary costs can have a significant dampening effect on public disclosures (Verrecchia 1983; Cheng et al. 2005; Wang 2007). Our paper reveals a setting where managers find it advantageous to share some proprietary information with competitors, and in doing so, are able to obtain proprietary competitor information. This

private exchange of proprietary information makes it more likely that managers issue forecasts and makes such forecasts more accurate. Prior work also finds evidence of intra-industry information transfers through public disclosure (Baginski 1987; Han, Wild, and Ramesh 1989; Pyo and Lustgarten 1990; Kim, Lacina, and Park 2008). Our findings show that such transfers also happen privately, and are more effective when both parties actively share information than when they are passive participants in an industry association. Overall, our results suggest that future work should consider the presence of formal structures that facilitate intra-firm information sharing in considering the role of proprietary costs and competitor's disclosures in shaping a firm's information environment.

Section 2 provides institutional background on standard setting organizations. Section 3 reviews prior literature and provides empirical predictions. Section 4 describes the sample and research design. Section 5 presents results and Section 6 concludes.

3.2. Institutional Background

3.2.1 Co-opetition

Competitors typically strive for increased market share without participating in collaborative efforts. However, some competitors organize themselves into clusters and collaborate with each other (Bougrain and Haudeville 2002; Ganguli 2007; Levy et al. 2003). This hybrid behavior, which consists of elements of both cooperation and competition, is known as "co-opetition" (Brandenburger and Nalebuff 1995), and has been increasingly popular in technology-related industries that benefit from standardization (Bengtsson and Kock 2000; Chen 2008; Gnyawali et al. 2006).

Prior work finds that co-opetition has both advantages and disadvantages. Through co-opetition, firms can gain beneficial access to additional know-how, skills, and resources (Ma 1999). They can also create a network market where a system of products

from different manufacturers inter-operate, resulting in higher consumer utility and greater collective profits for firms. Unlike collusion, co-opetition can be socially desirable as it can practically solve several challenges such as shrinking product life cycles, need for heavy investments in R&D, convergence of multiple technologies, and importance of technological standards (Garud 1994; Gnyawali and Park 2009; Gomes-Casseres 1994). The main disadvantage of co-opetition is the high risk of opportunism as firms have incentives to defect and to use shared information for their own purposes (Levy et al. 2003; Zerbini and Castaldo 2007).

We examine a potential unintended benefit of co-opetition: an improvement in a firm's information environment. By cooperating with competitors, managers can get additional insights into the performance and investment efforts of their competitors, as well as the industry as a whole. Managers can also learn more quickly about the viability and market potential of new products that are developed within the co-opetitive environment. Finally, managers can control and track the amount of proprietary information they share with competitors in the co-opetitive environment, and thus have a clearer sense of how much, if any, proprietary information would be revealed through public disclosure. Each of these benefits has the potential to affect a manager's voluntary forecasting ability, as well as analysts' use of management forecasts. We study these effects in an important venue for co-opetition: standard setting organizations.

3.2.2 Standard Setting Organizations

Standard Setting Organizations (SSOs) are voluntary private organizations that aim to create a consensus among technology developers and commercializers as to a set of common standards for the technology.⁴⁶ Such a consensus serves as a focal point for

⁴⁶ Historically, governments and regulators have played little role in setting standards. For example, time zones were developed by private railroad companies in the 1800s, and are maintained today

industry coordination and leads to a bandwagon process among adopters. Because innovations are typically not promulgated by a single firm, but rather draw together technologies developed in multiple firms, the coordination role played by SSOs has become increasingly critical in the modern economy. Many technology firms invest substantially in these efforts. For example, IBM spent an estimated \$500 million — roughly 8.5 percent of its R&D budget — on standards development in 2005 alone (Hardy, 2005).

Inter-firm information exchange at SSOs often results in major technological change and growth of the related product markets. Standardization is an important step in a technology life cycle as it facilitates commercialization of the technology. SSOs serve as an open and active forum through which firms exchange information and influence the standard development process. Inter-firm information exchange is the very mechanism through which a technology standard is shaped and accepted. The U.S. Department of Justice allows SSOs to serve as a forum for direct communications among peer firms despite potential collusion concerns because of the societal benefits of the network effects (Garud 1994; Gnyawali and Park 2009; Gomes-Casseres 1994).

Each SSO typically has various technical committees and working groups within the organization (see Appendix 3.A for an example of a SSO and its committees). These committees develop different aspects of a technology standard. Given that the total number of SSO firms is often too large to permit effective discussion, these committees serve to facilitate more effective discussions among participants with similar expertise to contribute. Contributing firms voluntarily choose which committees to join depending on their interests and relevance to each committee. They may contribute to as many

by the ISO (International Organization for Standardization), which is an independent, non-governmental organization. This tradition of private standard setting continues today in the tech sector.

committees as they want, or not participate in them at all. In these committees, “firms and other constituencies share technical information, adjudicate technological differences, select standards, and negotiate future developments” (Rosenkopf, Metiu and George 2001). Thus, we expect that firms contributing to committees will have access to much more information about their competitors and about the product market than firms not actively participating in committees. We exploit this differential access to competitive information to test whether firms that being contributing to committees have improvements in their information environments, relative to a control sample of passive SSO firms that are not participating.

SSO-contributing firms typically have personnel designated to participate in the standard-setting process. Although these representatives have relevant technical knowledge, they are not necessarily engineers who engage in the R&D function at the firms. Nor are they typically the CEO or CFO. If the standard setting process works in isolation from the rest of the firm’s information gathering efforts, it would work against us finding an effect of active SSO participation on the firm’s information environment. However, we expect that the participating representatives debrief other company personnel after the committee meetings, and that such information is ultimately incorporated by the CFO into sales and earnings forecasts.

3.3. Empirical Predictions

3.3.1 Decision to Issue Management Forecasts

We expect that active SSO participation will be related to a manager’s decision to issue forecasts. Prior work finds the managers voluntarily decide to issue forecasts to obtain benefits such as aligning investor expectations; reducing information asymmetry, return volatility, and cost of capital; signaling their ability; and reducing expected litigation

costs (e.g., Ajinkya and Gift 1984; Hassell and Jennings 1986; Trueman 1986; King et al. 1990; Skinner 1994; Kasznik and Lev 1995; Coller and Yohn 1997; Billings, Jennings, and Lev 2015). A major deterrent to issuing forecasts is expected proprietary costs (Verrecchia 1983). Consistent with this theory, prior work finds that firms with high R&D expenditures are less likely to issue earnings forecasts and forecast less frequently than low R&D firms (Cheng et al. 2005; Wang 2007).

Another important factor that drives management forecast issuance is predictability. Managers are more likely to issue forecasts when earnings are less volatile and easier to predict (Waymire 1985; Chen, Matsumoto, and Rajgopal 2011). Prior forecast accuracy affects the credibility of forecasts, suggesting that the decision to forecast is influenced by the firm's prior accuracy (Williams 1996; Hutton and Stocken 2007). Similarly, firms that consistently fall below analyst estimates tend to stop providing forecasts; when they resume, their record of meeting analysts' forecasts improves (Houston et al. 2007). Samuels (2017) finds that firms with improvements in internal information systems due to government contracting increase their forecasting behavior.

Based on this research, there are two reasons to expect that information sharing within SSOs would affect the likelihood of issuing forecasts. First, to the extent that proprietary information is already shared with competitors, firms likely face lower expected proprietary costs in issuing additional public disclosure. Second, the opportunity to gather competitor information should increase the predictability of sales and earnings. Thus, we predict that firms actively contributing to SSO committees will be more likely to issue forecasts after initiating their collaboration, compared to passive SSO firms during the same period (i.e., firms that belong to the SSO, but do not share information in committees).

To provide a comprehensive picture of where SSO information sharing has the biggest impact, we examine forecasts of sales and earnings for both annual and quarterly forecast horizons. We expect a larger effect on annual forecasts because such forecasts are less predictable than quarterly forecasts (Hirst, Koonce, and Venkataraman 2008), and hence there are larger benefits to the additional information gained in SSO activity. We also expect a larger effect for sales forecasts than for earnings forecasts because much of the SSO activity involves commercialization, and hence affects future sales more directly than future earnings.

3.3.2. Management Forecast Accuracy

We predict that active SSO participation will be related to the accuracy of management forecasts (i.e., the absolute value of the forecast error). Prior work finds that a manager's ability to forecast accurately depends on many factors, including the firm's complexity; the volatility of its earnings; the quality of its accounting and information systems; managerial talent, prior forecasting behavior, and the degree to which its earnings are driven by firm-specific factors (versus industry or macroeconomic factors) (see Hirst, Koonce, and Venkataraman 2008 for a review). Prior work also finds that forecasts by one firm affect the information environment of firms in the same industry (Baginski 1987; Han, Wild, and Ramesh 1989; Pyo and Lustgarten 1990; Kim, Lacina, and Park 2008). This evidence is consistent with firms in the same industry facing similar economic shocks, production-technology advancements, and government regulations (Schipper 1990). Thus, information about a competitor firm has the potential to greatly improve a manager's information about future industry or macroeconomic effects on sales and earnings.

Active SSO participation allows managers to gather information on industry and macroeconomic effects that are difficult to tease out by only looking at their own firms'

information sets. Essentially, active SSO participation should have a similar impact to the information transfer in public forecasts, with the SSO interactions potentially providing information that is more precise because the firm receives finer competitor information than just a forecast. Thus, we predict that firms actively contributing to SSO committees will issue forecasts are more accurate (i.e., lower absolute forecast errors) after initiating their collaboration, compared to passive SSO firms during the same period. Based on similar arguments as above, we expect a larger effect for annual forecasts and for sales forecasts.

3.3.3 Management Forecast Bias and News

While our primary focus is forecast issuance and accuracy, we also provide descriptive evidence on whether SSO information sharing affects forecast bias and news. Forecast bias is the unsigned forecast error; i.e., actual results minus management forecast. Prior work finds a pessimistic bias in short-horizon forecasts, as managers attempt to “walk down” analyst forecasts to a beatable level (Chen 2004; Cotter et al. 2006; Bergman and Roychowdhury 2007). In contrast, long-horizon forecasts tend to be optimistically biased (Choi and Ziebart 2004; Rogers and Stocken 2005; Bergman and Roychowdhury 2007). Conditional on this horizon-related bias, managers are more likely to be optimistically biased for strategic reasons like upcoming security offerings, high financial distress, less-competitive industries, lower litigation risk, and high earnings volatility (which masks bias) (see Hirst, Koonce, and Venkataraman 2008 for a review).

Prior work also examines forecast news, which is defined as the management forecast minus the consensus analyst forecast at the time of forecast issuance. Hutton and Stocken (2007) find that bad news forecasts are more common (46% of their sample) than good news (37%) and confirming forecasts (17%). Bad news forecasts are more

common for large earnings surprises, for high litigation risk firms, and forecasts near the end of the fiscal period (Kasznik and Lev 1995; Anilowski, Feng, and Skinner 2007).

We do not make directional predictions for how inter-firm information transfers would affect forecast bias and news because the association is unclear *ex ante*. To the extent that managers use bias and news strategically, better information through SSO activity could allow them to more precisely bias their forecasts. For example, a manager wishing to issue a pessimistically biased forecast to walk down expectations would be able to do so more precisely with a richer information set. In contrast, if a certain bias or news in forecasts prior to SSO participation reflects a rational response to a certain information deficiency (e.g., avoid good news forecasts because they are less certain without information on competitors), then the improved information from SSO participation could lead to more unbiased and confirming forecasts. Thus, we do not make predictions for these results, but rather provide them as descriptive evidence on how SSO information sharing affects other forecast properties.

3.3.4 Analyst Forecast Dispersion

Finally, we examine how SSO participation affects analyst forecasts. Prior work finds that analysts revise their forecasts after management forecasts, generally in the same direction as the management forecast news (Jennings, 1987; Hassell et al., 1988; Baginski and Hassell 1990; Williams, 1996; Hansen and Noe 1999). Such analyst forecast revisions are greater when the forecasting manager has higher high prior forecast accuracy (Williams 1996). In addition to using management forecasts to improve their forecasts, prior work finds that analysts glean useful information from managers through additional disclosures such as conference calls and conference presentations (Mayew, Sharp, and Venkatachalam 2013; Green, Jame, Markov, and Subasi 2014).

Analysts are aware of which firms are participating in SSOs because their questions during conference presentations and their narratives in analyst reports often discuss the firm's SSO activity (see Appendix B for examples). There are three potential mechanisms for a firm's active SSO participation to affect analyst forecasts; specifically, reduce forecast dispersion by creating more commonality in the analysts' information sets. First, analysts will expect management forecasts to become more accurate once firms have access to competitor information through SSO information sharing. Second, managers can provide analysts better supplemental information through conference presentations and conference calls when they are active in the SSO. Third, analysts can better forecast industry trends if they know which firms are working together through SSOs. Thus, we predict that firms actively contributing to SSO committees will have lower analyst forecast dispersion after initiating their collaboration, compared to passive SSO firms during the same period.

3.4. Data, Sample Construction, and Empirical Design

3.4.1 Data

We collect data on accounting and stock market information from the intersection between CRSP and Compustat, management forecast and analyst forecast information from IBES, and data on firms' past patent output from Noah Stoffman's website (Kogen et al., 2017).

We obtain the list of SSO participants and committee contributors for nine SSOs between 1996 and 2014 from Northwestern's Searle Center on Law, Regulation, and Economic Growth. Panel A of Table 3.1 lists the nine SSOs, together with examples of their standards and the number of participating firms. The total number of participants in the nine SSOs is 847. Some firms participate in multiple SSOs; the number of unique firms

in the data is 550. The largest SSOs in the sample are those that issue standards for computing networks (20.5% of the sample), telecom (19.6%), and wireless networks (14.5% and 8.6% in two SSOs).

Using this data, we can identify whether a given firm participates passively in the SSO (e.g., by licensing the developed technology) or contributes actively to the committee meetings during which the standards are actually developed. There are 1,679 committees in our data, with a mean of 2.87 sample firms per committee and the number ranging from 1 to 71 (note, these numbers only include committee members that are covered by CRSP-Compustat).

3.4.2 Sample Construction

Our treatment sample includes firms that actively contribute to an SSO committee. We identify the treatment year as the first time a treatment firm makes a contribution to any SSO committee. Panel A of Table 3.2 shows that, among the 550 unique firms in the SSO dataset, 253 are first-time participants in a committee (i.e., treatment firms) and 247 are only passive participants that never contribute to a committee. After removing 108 treatment firms that are not in the CRSP-Compustat universe and an additional 26 firms that are missing values of variables for the propensity score matching (PSM) model (see below), we have 119 treatment firms in the PSM model.

Panel B of Table 3.2 shows the number of first-time contributors by year during our sample period. We observe the largest number of first-time contributions in 1997, which is when a number of SSO committees were formed; e.g., DVD standards and ETSI Wireless Network standards. Panel C documents the sample composition of first-time contributors in terms of two-digit SIC industry membership. The most frequent industries are Electronic and Other Electrical Equipment and Components, Except Computer (SIC code 36; 34.5% of the sample), Industrial and Commercial Machinery and Computer

Equipment (SIC code 35; 15.1%), Business Services (SIC code 73; 14.3%), and Communications (SIC code 48, 9.2%). We will include year and industry fixed-effects in the analyses to account for any effects of clustering of observations.

We construct a pool of candidate firm-years from which we ultimately select the control firm-years as follows. First, for treatment firms, we include all years that satisfy two criteria: (1) the firm is passively participating in an SSO in that year and (2) the year is earlier than the first-time contribution year. Thus, a firm is dropped from the pool of candidates in the year that it makes its first contribution to a committee. Second, for firms that never actively contribute to a SSO committee, we include all years during which the firm is a passive member of the SSO.

We estimate the PSM logit model on this sample of treatment and candidate firms. We include a number of variables that potentially explain incentives to participate in an SSO committee for the first time. SSO committee contribution is costly because contributors have to send engineers to committee meetings, to identify internally which of their patents a new technology might infringe on, and to disclose those patents to other contributors. Larger and more profitable firms have more resources available to make costly contributions to SSO committees. R&D-intensive firms are more likely involved in the actual development of new technologies than firms that do not engage in R&D, who are likely to license the technologies from contributors once development is completed. Finally, firms with more growth options likely have a prospector strategy and strive to pioneer the commercialization of new technologies rather than be a second-mover by licensing new technologies from others. Thus, the variables that we include in the logit model include firm size ($\ln(\text{Assets})$), R&D intensity ($R\&D / \text{Assets}$), profitability (ROA), and growth opportunities as measured by the book-to-market ratio ($\text{Book} / \text{Market}$) and by sales growth (Sales Growth). All of these variables are lagged by one year.

Panel A of Table 3.3 shows the results of the logit model. The number of observations is 1,191, which includes the treatment firm-years and candidate firm-years using the algorithm described above. We find that firm size, R&D intensity, and sales growth are positively and significantly associated with the probability of a first-time committee contribution.

We use the propensity scores from this model to choose control firms from the pool of candidate firm-years. We select a maximum of three control firm-years per treated firm-year using nearest-neighbor matching without replacement. We select three control firm-years in order to increase the power of our tests. For every match, we impose the constraint that the control observation must come from the same fiscal year as the treated observation to mitigate the influence of potentially unobservable differences between treated and control observations that are related to the time period. The fact that all treatment observations and all control observations are participants in SSOs further increases the similarity between treatment and control observations.⁴⁷ We are unable to find close matches for 31 treatment firms, bringing our final sample of treatment firms down to 88 firm-years. We are able to find 227 control firm-years for our matched sample.

In Panel B of Table 3.3, we examine whether the PSM approach achieves covariate balance on the variables used in the logit regression, as well as on other firm characteristics. We find no significant differences for total assets, R&D, profitability, book-to-market, and sales growth, with the lowest two-tailed p-value being 0.2 ($Ln(Assets)$). In addition, we find that the means of treatment and control observations are indistinguishable from each other for stock return volatility (*Return Volatility*), whether or

⁴⁷ Since we measure treatment at the firm-year level rather than the firm-year-SSO level, and since several firms participate in many SSO and contribute to several committees at the same time, we cannot match treatment firms to control firms strictly within the same SSO.

not a firm issues sales or EPS guidance (*Sales Guidance*, *EPS Guidance*), cash holdings (*Cash / Assets*), leverage (*Debt / Assets*), investments in fixed assets (*Capex / Assets*), the number of years since the firm first appeared on CRSP (*Firm Age*), and stock market capitalization ($\ln(\text{Market Cap})$).

The only characteristic that differs significantly between treatment and control observations is the number of patents a firm was granted over the past five years ($\ln(\# \text{ Patents})$), which is significantly greater for treatment firms. This variable is only available until the year 2011. Hence, we do not match on this variable to avoid losing additional observations, but we run all our subsequent analyses with and without controlling for this variable.

3.4.3 Research Design

To examine whether management and analyst forecast properties change for SSO-contributing firms around the time of their initial contribution, we estimate difference-in-differences analyses. For each treatment firm and control firm, we keep any of the three years before and after the treatment or placebo year if we have data on the firm's SSO, the dependent variable, and control variables for that year. The empirical specification that we use throughout our analyses is as follows

$$DV = \alpha_t + \alpha_{SIC2} + \beta * Treatment + \gamma * Post + \lambda * Treatment * Post + \nu * Controls + \varepsilon \quad (3.1)$$

where α_t and α_{SIC2} are year fixed effects and two-digit SIC industry fixed effects, respectively, and standard errors are clustered by firm. $Treatment * Post$ is the difference-in-differences estimator.

We examine a number of dependent variables (DV), and the unit of analysis differs depending on the DV. When the DV is an indicator for management earnings or sales forecasts in a given year (*EPS Forecaster* or *Sales Forecaster*) or the frequency of management earnings or sales forecasts per year (*EPS Forecast Freq* or *Sales Forecast*

Freq), the unit of analysis is at the firm-year level. When the DV is management forecast accuracy, bias, or news, the unit of analysis is at the forecast level. We define management forecast accuracy (*Abs(Error)*) as the unsigned difference between actual EPS (or sales) and the management forecast of EPS (or sales), scaled by share price (or actual sales). Similarly, we define management forecast bias (*Bias*) as the signed difference between actual EPS (or sales) and the management forecast of EPS (or sales), scaled by share price (or actual sales). We define management forecast news (*News*) as the signed difference between the management forecast of EPS (or sales) and the analyst consensus forecast of EPS (or sales) at the time of the forecast, scaled by share price (or actual sales). Finally, when the dependent variable is analyst forecast dispersion (*Dispersion*), the unit of analysis is at the firm-month level. We calculate *Dispersion* as either the standard deviation of all EPS forecasts provided by unique analysts in a given firm-month, scaled by share price, or the standard deviation of all sales forecasts, scaled by actual sales. We require at least two forecasts to compute the dispersion measures.

Table 3.4 presents descriptive statistics on the DVs. Panel A reports firm-year level management forecast issuance variables. Almost half of the sample issues sales (45.8%) and earnings (47.2%) forecasts in a given year, with quarterly forecasts more commonly issued than annual forecasts (~38% vs. ~23%). The mean number of forecasts is around 2.3 per year.

Panel B reports the management forecast properties variables, which are measured at the forecast level. As expected, quarterly EPS forecasts (mean *Abs(Error)* = 0.005) are more accurate than annual EPS forecasts (mean *Abs(Error)* = 0.011). However, sales forecasts exhibit almost the same accuracy between annual and quarterly forecasts (mean *Abs(Error)* = 0.058 and 0.060, respectively). Consistent with prior work, the mean *Bias* for both sales and EPS forecasts is positive, which reflects a pessimistic bias in the

forecast (i.e., actual EPS is greater than the forecast). Also consistent with prior work, the mean *News* for both types of forecasts is negative, which reflects a greater incidence of bad news forecasts (vis-à-vis the consensus analyst forecast at the time).

Panel C reports the analyst forecast dispersion variables, which are measured at the firm-month level. As expected, analyst forecast dispersion is larger for annual forecasts than for quarterly forecasts.

3.5. Empirical Results

3.5.1 Decision to Issue Management Forecasts

We first test whether inter-firm information sharing through SSO committee participation is associated with a greater likelihood of issuing a management forecast. We estimate equation (3.1) with the DV as an indicator for sales or earnings forecast issuances during a firm-year (*Sales Forecaster* or *EPS Forecaster*). We estimate models that use all forecast horizons, annual forecasts only, and quarterly forecasts only. We also estimate a model on the full sample and on a restricted sample that includes a control for patent data (which is only available until 2011).

Table 3.5, Panel A presents results for sales forecast issuances. For all forecast horizons (columns (1) and (2)), the coefficient on *Treatment * Post* is positive and significant, indicating that firms are more likely to issue sales forecasts after they initiate active contributions to an SSO committee for the first time. This result is largely driven by the issuance of annual sales forecasts, as *Treatment * Post* is positive and significant in the annual forecast regression (columns (3) and (4)), but positive and insignificant in the quarterly forecast regression. These results hold regardless of whether we include a control for patent activity. Interestingly, the coefficient on *Treatment* is negative and significant in the annual forecast regression. Thus, SSO-contributing firms were less likely to issue annual sales forecasts than control firms prior to initiating cooperation, and

become more likely afterwards, indicating that the forecasting benefits of information sharing are large for such firms.

Panel B presents results for EPS forecasts. The coefficient on *Treatment * Post* is not significantly different from zero in any of the models. Thus, information sharing in SSO committees provides benefits for forecasting annual sales, but has seemingly little impact on encouraging earnings forecasts.

We also estimate the models with the DV as the number of sales or earnings forecasts issued during the firm-year (*Sales Forecast Freq* or *EPS Forecast Freq*). The results are identical to the indicator variable specification; the coefficients on *Treatment * Post* are positive and significant for all and annual sales forecasts, and insignificant for quarterly sales and all EPS forecasts (untabled). Overall, the results support our prediction that SSO information sharing increases the likelihood that managers issue forecasts, but only for annual sales forecasts, suggesting that the industry and competitor information gleaned through SSO collaboration is most useful for resolving uncertainty about product market growth over long horizons.

3.5.2. Management Forecast Accuracy

One drawback to the forecast issuance results is that managers are trading off other benefits and costs of issuing forecasts. It is possible that the benefits from the SSO collaboration are not be large enough to overcome these other factors in the decision. Thus, we next look only at firms that have decided to issue forecasts to test whether the information gained through SSO activities has a significant effect on forecast accuracy. The DV in these regressions is the unsigned difference between the actual sales or earnings and the management forecast of sales or earnings (*Sales Abs(Error)* or *EPS Abs(Error)*). We again estimate models separately for annual and quarterly forecasts and

for the full sample and patent-data sample.⁴⁸ We also include an indicator variable that is equal to one for management forecasts that are a revision of a prior forecast and equal to zero for initial forecasts (*Forecast Revision*).

Panel A of Table 3.6 presents results for sales forecasts. The coefficients on *Treatment * Post* are negative and significant for the annual sales forecast models, indicating that annual sales forecast accuracy improves in the three years after a firm initiates SSO committee collaboration. The benefits of collaboration again seem to be smaller for quarterly sales forecasts, as the coefficients on *Treatment * Post* are insignificant in the quarterly forecast model.

Panel B presents results for earnings forecasts. For both annual and quarterly forecasts, the coefficients on *Treatment * Post* are negative and significant, consistent with inter-firm information transfer in SSOs improving the accuracy of EPS forecasts. Thus, while SSO activity does not alter the cost-benefit trade-off enough to encourage more earnings forecast issuances, it does improve the company's information set enough to significantly reduce forecast error. These results are consistent with our prediction that actively contributing to SSO committees brings information benefits to the firm, leading to more accurate forecasts.

Notably, Table 3.6 shows that, for both sales and earnings forecasts, the coefficients on *Treatment* are positive and significant. This result indicates that, prior to their first-time contributions, SSO-contributing firms have less accurate forecasts than control firms, which is consistent with such SSO-contributing firms having more uncertainty about how competitors' actions will affect their long-horizon earnings and sales

⁴⁸ We do not combine annual and quarterly forecasts together in this analysis because the magnitudes and standard deviations of the forecast errors are very different between annual and quarterly forecasts.

forecasts. Through active collaboration with competitors, these treatment firms are then able to close the information gap and issue significantly more accurate forecasts.

3.5.3. Management Forecast Bias and News

Although it is *ex ante* unclear how inter-firm information sharing in SSOs would affect forecast bias and news, we provide descriptive evidence on whether better competitor information is associated with changes in bias and news of management forecasts.

Table 3.7 presents the results of estimating equation (3.1) with a DV of forecast bias, defined as the signed difference between the actual amount and the management forecast. Panel A shows results for sales forecasts. The coefficients on *Treatment* are negative and significant for both annual and quarterly forecasts, indicating a more optimistic bias for treatment firms prior to initiating SSO committee activity. After the first-time contribution to an SSO, the optimistic bias is mitigated, as evidenced by the positive and significant coefficient on *Treatment * Post* in all specifications.⁴⁹ Thus, it appears that SSO-contribution firms have an optimistic view of their product's sales potential before actively engaging in the SSO; once they have access to their competitor's information, their forecasts exhibit the same level of pessimistic bias as the control firms (as evidence by the insignificant *p*-value in the last row for the test: $Treatment + Treatment * Post = 0$).

Panel B of Table 3.7 shows that the coefficients on *Treatment * Post* are insignificant in all specifications. Thus, inter-firm information sharing does not affect bias in earnings forecasts.

⁴⁹ Because the specifications include industry-year fixed effects, which would represent the bias for control firms prior to their pseudo-event date, it is difficult to see whether the coefficients represent an absolute optimistic or pessimistic bias. The mean bias in annual sales forecasts for control firms in the pre period is 0.023. Using the coefficients in column (2) for annual sales, this means that treatment firms had a mean optimistic bias of -0.073 in the pre period ($0.023 - 0.096$), which flips to a mean pessimistic bias of 0.024 in the post period ($0.023 - 0.096 - 0.009 + 0.106$).

Table 3.8 presents the results of estimating equation (3.1) with a DV of forecast news, defined as the signed difference between the management forecast and the consensus analyst forecast at the time of management forecast issuance. Panel A shows results for sales forecasts. Again, the coefficients on *Treatment* are negative and significant for both annual and quarterly forecasts, indicating a tendency to provide more bad news forecasts prior to commencing SSO committee activity. In the case of annual forecasts, the coefficients on *Treatment * Post* are positive and significant, which mitigates the greater bad news bias of treatment firms.⁵⁰ This finding is only seen for annual sales forecasts, as the coefficients on *Treatment * Post* are insignificant for quarterly sales forecasts and, in Panel B, for annual and quarterly earnings forecasts (with the exception of one marginally significant coefficient for quarterly earnings in the full sample).

Putting these findings together, the evidence suggests that, prior to the treatment year, SSO-contributing firms issue more pessimistic forecasts (compared to analyst consensus) than control firms. In addition, prior to the treatment year, SSO-contributing firms issue more positively biased forecasts (compared to realizations) than control firms. However, in the post treatment period, all significant differences in forecast news and bias between treated and control firms disappear.

3.5.4. Analyst Forecast Dispersion

Our final analysis examines whether active SSO participation has a spill-over effect on analysts' information sets, leading to less dispersion in their forecasts. We estimate firm-month specifications of equation (3.1) using a DV of analyst dispersion, which is either

⁵⁰ The mean news of annual sales forecasts for control firms in the pre period is -0.014. Using the coefficients in column (2), this means that treatment firms had a mean news of -0.057 in the pre period (-0.014 - 0.043) and -0.019 in the post period (-0.014 - 0.043 - 0.004 + 0.042). Thus, treatment firms still exhibit a bad news bias, but it is much closer to zero.

the standard deviation in analyst EPS forecasts, scaled by price, or the standard deviation of analyst sales forecasts, scaled by actual sales.

Panel A of Table 3.9 presents results for sales forecasts. Across all specifications, for both quarterly and annual analyst sales forecasts, we find no significant differences in forecast dispersion between SSO-contributors and control firms. Thus, while SSO-contributing firms are more likely to issue annual sales forecasts after initiating collaboration, and while such forecasts are more accurate, analysts do not appear to consistently incorporate this information into their sales forecasts.

Panel B shows the results for earnings forecasts. Consistent with our prediction, the coefficients on *Treatment * Post* are negative and significant for three of the four specifications (with the *p*-value = 0.105 in the fourth), providing evidence of a reduction in dispersion for forecasts of SSO-contributing firms after their first committee collaboration. This finding suggests that, in the case of earnings forecasts, the increased credibility of the more accurate management forecasts and the analysts' ability to observe which firms are active collaborating combine to increase the commonality among analysts' information sets, and hence reduce earnings forecast dispersion for treatment firms.

3.6. Conclusion

This paper shows that actively collaborating with competitors ("co-opetition") creates unintended benefits for a firm's information environment. Firms that actively share proprietary information with competitors in Standard Setting Organizations (SSO) are more likely to issue annual sales forecasts after initiating collaboration, relative to a matched sample of control firms that passively belong to the SSO. SSO-contributing firms also experience an improvement in the accuracy of annual sales and earnings forecasts, as well as a reduction in the dispersion of analysts' earnings forecasts. Thus, through active collaboration with competitors, SSO-contributing firms are able to access

competitor and industry information, which increases the likelihood that managers issue forecasts and allows managers to issue more accurate forecasts.

Our findings are subject to a number of caveats. First, the information benefits of co-opetition are not widespread and are concentrated in longer-horizon product market information. Thus, while we find consistent evidence that initiating active SSO contributions affects annual sales forecasts, the results are less consistent (or insignificant) for earnings forecasts and for quarterly forecasts. Second, prior to initiating SSO information sharing, SSO-contributing firms exhibit different levels of forecast accuracy, as well as forecast bias and news, than SSO-passive firms. While we use propensity score matching to find control firms that would have similar incentives to contribute to an SSO based on size, growth, and R&D activity, there are still differences in terms of prior management forecast properties. Thus, we must be cautious about attributing causality to initiating active contributions to an SSO. However, it is unlikely the treatment firms decided to actively contribute to the SSO for forecasting benefits, which are almost certainly a second-order concern relative to the product market incentives for SSO participation. Our results are consistent with unintended information benefits to SSO participation, but we acknowledge the possibility exists that such benefits may have been a first-order determinant of active SSO participation.

In any case, our results suggest that future work should consider the presence of formal co-opetitive structures that facilitate inter-firm information sharing when examining the role of proprietary costs and competitor's disclosures in shaping a firm's information environment.

TABLE 3.1. Standard Setting Organizations Included in Sample

SSO Name	Examples of Technology	Number of Firms in SSO	Percent
ATIS: Alliance for Telecommunications Industry Solutions	Wireless networks (4G, 5G)	73	8.6%
ATSC: Advanced Television Systems Committee	Digital television	58	6.8%
CENSA: Collaborative Electronic Notebook Systems Association	eRecords (ELN, XML)	5	0.6%
Digital Versatile Discs (DVD) Forum	DVD	86	10.2%
ETSI: European Telecommunications Standards Institute	Wireless networks (GSM, DECT)	123	14.5%
IEEE: The Institute of Electrical and Electronics Engineers	Computing (WiFi, Bluetooth)	174	20.5%
OASIS: Organization for the Advancement of Structured Information Standards	Internet (SAML, CAMP)	90	10.6%
TIA: Telecommunications Industry Association	Telecom (Radio, Fiber optics)	166	19.6%
WFMC: Workflow Management Coalition	Digital workflow (XPDL, BPM)	72	8.5%
		847	

This table shows that nine Standard Setting Organizations (SSOs) for which we obtained data from the Searle Center on Law, Regulation, and Economic Growth at Northwestern University. The number of firms represents only companies that are in the CRSP-Compustat universe. Private firms and other participants (e.g. universities) are not included in the totals. Some firms belong to more than one SSO so the total number of firms does not represent the number of unique firms in the sample.

TABLE 3.2. Treatment Sample of First-Time SSO-Contributing Firms*Panel A: Selection of Treatment Sample*

Number of Unique Participating SSO firms	550
Less Passive Participants only	<u>(247)</u>
Number of First-Time Committee Participants	253
Less Firms Not in CRSP-Compustat	<u>(108)</u>
Number of First-Time Committee Participants in CRSP-Compustat	145
Less Missing Values of PSM Model Variables	<u>(26)</u>
Number of Treatment firms in PSM model	119

Panel B: First-Time Committee Contributions by Year

Year	Number	Percent
1990	4	3.4%
1992	1	0.8%
1993	7	5.9%
1994	2	1.7%
1995	11	9.2%
1996	4	3.4%
1997	21	17.6%
1998	6	5.0%
1999	6	5.0%
2000	3	2.5%
2001	9	7.6%
2002	5	4.2%
2003	6	5.0%
2004	5	4.2%
2005	5	4.2%
2006	3	2.5%
2007	3	2.5%
2008	4	3.4%
2009	3	2.5%
2010	1	0.8%
2011	2	1.7%
2012	4	3.4%
2013	2	1.7%
2014	<u>2</u>	1.7%
Total	119	

TABLE 3.2. Treatment Sample of First-Time SSO-Contributing Firms (continued)*Panel C: First-Time Committee Contributions by Industry*

2-digit SIC	Industry Description	Number	Percent
23	APPAREL AND OTHER FINISHED PRODUCTS MADE FROM FABRICS AND SIMILAR MATERIAL	1	0.8%
26	PAPER AND ALLIED PRODUCTS	1	0.8%
27	PRINTING, PUBLISHING, AND ALLIED INDUSTRIES	1	0.8%
28	CHEMICALS AND ALLIED PRODUCTS	6	5.0%
32	STONE, CLAY, GLASS, AND CONCRETE PRODUCTS	2	1.7%
33	PRIMARY METAL INDUSTRIES	3	2.5%
35	INDUSTRIAL AND COMMERCIAL MACHINERY AND COMPUTER EQUIPMENT	18	15.1%
36	ELECTRONIC AND OTHER ELECTRICAL EQUIPMENT AND COMPONENTS, EXCEPT COMPUTER	41	34.5%
37	TRANSPORTATION EQUIPMENT	6	5.0%
38	MEASURING, ANALYZING & CONTROLLING INSTRUMENTS; PHOTOGRAPHIC, MEDICAL & OPTICAL GOODS; WATCHES & CLOCKS	5	4.2%
39	MISCELLANEOUS MANUFACTURING INDUSTRIES	1	0.8%
48	COMMUNICATIONS	11	9.2%
49	ELECTRIC, GAS, AND SANITARY SERVICES	1	0.8%
50	WHOLESALE TRADE & DURABLE GOODS	2	1.7%
60	DEPOSITORY INSTITUTIONS	1	0.8%
67	HOLDING AND OTHER INVESTMENT OFFICES	1	0.8%
73	BUSINESS SERVICES	17	14.3%
87	ENGINEERING, ACCOUNTING, RESEARCH, MANAGEMENT, AND RELATED SERVICES	<u>1</u>	0.8%
	Total	119	

The table describes the treatment sample, which is comprised of firms that commence active contributions to an SSO committee. Panel A shows the number of unique firms, the number of firms that actively contribute to a committee, and the number of active contributing firms with the required data to join our treatment sample. We identify the treatment year as the first time a treatment firm makes a contribution to any SSO committee. Panel B shows the number of treatment years by calendar year. Panel C shows the two-digit SIC membership of the treatment firms.

TABLE 3.3. Propensity-Score Matching Model*Panel A: Propensity Score Matching Regression*

	Treatment Firm
<i>Ln (Assets)</i>	0.294*** (4.54)
<i>R&D / Assets</i>	3.235*** (2.70)
<i>ROA</i>	1.329 (1.56)
<i>Book / Market</i>	0.055 (0.23)
<i>Sales Growth</i>	0.484** (2.30)
Observations	1,191
Pseudo R-Square	0.059

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test

Panel B: Descriptive Statistics and Tests of Covariate Balance

	Treatment Firm-Years					Control Firm-Years					P-value diff in means
	Mean	Std Dev	25 th	50 th	75 th	Mean	Std Dev	25 th	50 th	75 th	
<i>Firm Characteristics in PSM Regression</i>											
<i>Ln (Assets)</i>	8.06	2.34	6.42	8.38	9.99	7.70	2.25	6.11	7.90	9.45	0.20
<i>R&D / Assets</i>	0.09	0.10	0.03	0.06	0.13	0.10	0.10	0.02	0.07	0.14	0.80
<i>ROA</i>	0.10	0.21	0.05	0.11	0.21	0.13	0.15	0.05	0.12	0.19	0.32
<i>Book / Market</i>	0.45	0.37	0.21	0.35	0.61	0.45	0.37	0.21	0.37	0.62	0.92
<i>Sales Growth</i>	0.23	0.79	-0.07	0.06	0.24	0.22	0.56	0.00	0.13	0.25	0.85
<i>Other Firm Characteristics</i>											
<i>Return</i>											
<i>Volatility</i>	0.53	0.31	0.27	0.44	0.75	0.58	0.32	0.35	0.47	0.76	0.20
<i>Sales</i>											
<i>Guidance</i>	0.28	0.45	0.00	0.00	1.00	0.34	0.47	0.00	0.00	1.00	0.35
<i>EPS Guidance</i>	0.43	0.50	0.00	0.00	1.00	0.42	0.50	0.00	0.00	1.00	0.89
<i>Cash / Assets</i>	0.24	0.21	0.08	0.17	0.34	0.25	0.20	0.08	0.20	0.38	0.60
<i>Debt / Assets</i>	0.16	0.16	0.00	0.13	0.29	0.18	0.20	0.01	0.13	0.27	0.39
<i>Capex / Assets</i>	0.05	0.04	0.02	0.04	0.07	0.06	0.05	0.02	0.05	0.09	0.14
<i>Firm Age</i>	2.60	1.05	1.70	2.71	3.31	2.42	0.95	1.61	2.56	3.14	0.15
<i>Ln (Market</i>											
<i>Cap)</i>	7.29	2.20	5.39	7.46	9.33	7.44	2.00	5.98	7.80	8.99	0.58
<i>Ln (# Patents)</i>	3.70	2.79	1.10	3.78	6.20	3.02	2.62	0.00	3.09	5.30	0.06

Panel A shows the results of firm-year logistic regressions of an indicator variable for treatment firms (see Table 2) on the determinants of first-time SSO committee contributions. We use fitted values from these regressions as propensity scores to draw three control firm-years for each treated firm-year based on nearest-neighbor matching. Control firm-years are drawn from the subsample of non-contributing firm-years that participate in SSOs during the same calendar year as treatment firm-years. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients. Panel B presents descriptive statistics and tests of covariate balance for the propensity score matched sample. Firm characteristics are measured for the year prior to the treatment year (i.e., first-time committee contribution) or placebo event (for control firms). The sample size is 88 for treatment firms and 227 for control firms, except for *Ln(# Patents)*, where the sample sizes are 58 and 179, respectively.

TABLE 3.4. Descriptive Statistics on Forecast Variables*Panel A: Management Forecast issuance and frequency*

	All Forecasts	Annual Forecasts	Quarterly Forecasts
	Mean	Mean	Mean
<i>Sales Forecaster</i>	0.458	0.223	0.383
<i>EPS Forecaster</i>	0.472	0.237	0.389
<i>Sales Forecast Freq</i>	2.364	0.804	1.560
<i>EPS Forecast Freq</i>	2.279	0.892	1.387

Panel B: Management Forecast Properties

	Annual Forecasts				Quarterly Forecasts			
	Mean	Std Dev	50 th	N	Mean	Std Dev	50 th	N
<i>Sales Abs(Error)</i>	0.058	0.095	0.027	730	0.060	0.088	0.040	1418
<i>EPS Abs(Error)</i>	0.011	0.015	0.005	799	0.005	0.009	0.002	1224
<i>Sales Bias</i>	0.010	0.095	0.015	730	0.034	0.068	0.032	1418
<i>EPS Bias</i>	0.001	0.017	0.002	799	0.002	0.007	0.001	1224
<i>Sales News</i>	-0.020	0.064	-0.012	618	-0.040	0.198	-0.020	1193
<i>EPS News</i>	-0.003	0.007	-0.001	619	-0.004	0.010	-0.001	923

Panel C: Analyst Forecast Dispersion

	Annual Forecasts				Quarterly Forecasts			
	Mean	Std Dev	50 th	N	Mean	Std Dev	50 th	N
<i>Sales Dispersion</i>	0.026	0.043	0.013	7277	0.023	0.034	0.013	6074
<i>EPS Dispersion</i>	0.008	0.023	0.003	8522	0.002	0.006	0.001	7392

Panel A presents descriptive statistics on management forecast issuance and frequency variables, which are measured at the firm-year level. *EPS Forecaster* (*Sales Forecaster*) is an indicator variable for management earnings (sales) forecasts in a given year. *EPS Forecast Freq* (*Sales Forecast Freq*) is the frequency of management earnings (sales) forecasts per year. Panel B presents the management forecast property variables, which are measured at the forecast level. *EPS Abs(Error)* (*Sales Abs(Error)*) is the unsigned difference between actual EPS (sales) and the management forecast of EPS (sales), scaled by share price (actual sales). *EPS Bias* (*Sales Bias*) is the signed difference between actual EPS (sales) and the management forecast of EPS (sales), scaled by share price (actual sales). *EPS News* (*Sales News*) is the signed difference between the management forecast of EPS (sales) and the analyst consensus forecast of EPS (sales) at the time of the forecast, scaled by share price (actual sales). Panel C presents analyst forecast dispersion variable, which are measured at the firm-month level. *EPS Dispersion* (*Sales Dispersion*) is the standard deviation of all EPS (sales) forecasts provided by unique analysts in a given firm-month, scaled by share price (actual sales). We require at least two forecasts to compute the dispersion measures.

TABLE 3.5. SSO Committee Participation and Management Guidance Frequency

Panel A: Dependent Variable: Sales Forecaster

	All Forecasts		Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Treatment</i>	-0.061 (-0.75)	-0.101 (-1.20)	-0.148* (-1.94)	-0.147** (-2.07)	0.005 (0.06)	-0.013 (-0.15)
<i>Post</i>	-0.054* (-1.94)	-0.071** (-2.54)	-0.051* (-1.81)	-0.057* (-1.89)	-0.031 (-0.93)	-0.039 (-1.13)
<i>Treatment * Post</i>	0.169** (1.98)	0.207** (2.33)	0.165* (1.97)	0.169* (1.89)	0.104 (1.20)	0.126 (1.40)
<i>Ln (Assets)</i>	-0.030* (-1.70)	-0.050**	0.002 (0.17)	-0.030* (-1.90)	-0.029 (-1.62)	-0.026 (-1.05)
<i>Ln (# Patents)</i>		0.029 (1.64)		0.037** (2.45)		0.011 (0.60)
<i>Return Volatility</i>		-0.049 (-0.41)		-0.121 (-1.22)		0.128 (1.00)
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	909	843	909	843	909	843
Adjusted R-Square	0.516	0.519	0.241	0.264	0.421	0.406

Panel B: Dependent Variable: EPS Forecaster

	All Forecasts		Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Treatment</i>	-0.002 (-0.02)	-0.055 (-0.55)	-0.118 (-1.32)	-0.121 (-1.38)	0.083 (0.88)	0.051 (0.52)
<i>Post</i>	-0.091** (-2.48)	-0.117*** (-3.10)	-0.056* (-1.82)	-0.067** (-2.23)	-0.071* (-1.85)	-0.087** (-2.14)
<i>Treatment * Post</i>	-0.038 (-0.40)	-0.013 (-0.14)	0.061 (0.87)	0.054 (0.75)	-0.079 (-0.86)	-0.070 (-0.73)
<i>Ln (Assets)</i>	0.004 (0.18)	-0.031 (-0.97)	0.019 (1.23)	-0.030 (-1.53)	-0.002 (-0.08)	-0.009 (-0.30)
<i>Ln (# Patents)</i>		0.032 (1.61)		0.026 (1.53)		0.014 (0.72)
<i>Return Volatility</i>		-0.311** (-2.13)		-0.483*** (-3.29)		-0.046 (-0.32)
Industry and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	909	843	909	843	909	843
Adjusted R-Square	0.162	0.192	0.0822	0.142	0.129	0.124

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test
 Panel A (Panel B) presents results of OLS regressions with *Sales Forecaster* (*EPS Forecaster*)—an indicator for a sales (EPS) forecast in a firm-year—as the dependent variable. *Treatment* = 1 for firms that contribute to SSO committees and *Treatment* = 0 for firms that do not. For each treatment (control) firm, we keep the three years prior to the treatment (placebo) year, where *Post*=0, and three years subsequent, where *Post*=1. *Treatment * Post* measures whether the change from before to after the treatment or placebo year is significantly different between treatment firms and control firms. Other variables are defined in Table 3. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients.

TABLE 3.6. SSO Committee Participation and Management Guidance AccuracyPanel A: *Dependent Variable: Sales Abs(Error)*

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	0.060*** (3.22)	0.054** (2.58)	-0.009 (-0.95)	-0.011 (-1.03)
<i>Post</i>	-0.006 (-0.85)	-0.007 (-0.87)	-0.011* (-1.69)	-0.012 (-1.60)
<i>Treatment * Post</i>	-0.061** (-2.61)	-0.065** (-2.54)	0.001 (0.09)	0.002 (0.14)
<i>Ln (Assets)</i>	-0.010** (-2.12)	-0.008* (-1.99)	-0.002 (-0.96)	-0.001 (-0.27)
<i>Forecast Revision</i>	-0.033*** (-3.64)	-0.039*** (-4.23)	-0.019** (-2.42)	-0.018** (-2.07)
<i>Ln (# Patents)</i>		0.003 (0.84)		-0.001 (-0.21)
<i>Return Volatility</i>		0.043 (0.88)		0.000 (0.01)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	730	622	1,418	1,252
Adjusted R-Square	0.283	0.318	0.215	0.206
Post Diff P-value	0.928	0.434	0.367	0.385

Panel B: *Dependent Variable: EPS Abs(Error)*

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	0.009*** (3.01)	0.005** (2.04)	0.002 (1.47)	0.002 (1.22)
<i>Post</i>	-0.000 (-0.22)	-0.001 (-1.39)	-0.000 (-0.14)	0.000 (0.08)
<i>Treatment * Post</i>	-0.006** (-2.14)	-0.005* (-1.97)	-0.003* (-1.83)	-0.003* (-1.67)
<i>Ln (Assets)</i>	-0.002* (-1.85)	-0.003*** (-2.89)	-0.002*** (-2.92)	-0.002** (-2.61)
<i>Forecast Revision</i>	-0.006*** (-3.57)	-0.007*** (-3.84)	-0.001 (-1.60)	-0.001 (-1.54)
<i>Ln (# Patents)</i>		0.002*** (2.84)		0.000 (0.36)
<i>Return Volatility</i>		0.017* (1.96)		0.006 (0.92)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	799	719	1,224	1,119
Adjusted R-Square	0.205	0.255	0.104	0.113
Post Diff P-value	0.370	0.990	0.248	0.198

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test

**TABLE 3.6. SSO Committee Participation and Management Guidance Accuracy
(continued)**

Panel A (Panel B) presents results of OLS regressions with *Sales Abs(Error)* (*EPS Abs(Error)*)—the unsigned difference between actual sales (EPS) and management forecast of sales (EPS), scaled by sales (price)—as the dependent variable. *Treatment* = 1 for firms that contribute to SSO committees and *Treatment* = 0 for firms that do not. For each treatment (control) firm, we keep the three years prior to the treatment (placebo) year, where *Post*=0, and three years subsequent, where *Post*=1. *Treatment * Post* measures whether the change from before to after the treatment or placebo year is significantly different between treatment firms and control firms. *Forecast Revision* is an indicator variable that is equal to one for management forecasts that are a revision of a prior forecast and equal to zero for initial forecasts. Other variables are defined in Table 3. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients. Post Diff P-value is a *p*-value for the test *Treatment + Treatment * Post* = 0; i.e., whether the post-treatment level of the variable for treatment firms is significantly different than the pre-level for control firms.

TABLE 3.7. SSO Committee Participation and Management Guidance Bias*Panel A: Dependent Variable: Sales Bias*

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	-0.096*** (-3.37)	-0.096*** (-3.42)	-0.016** (-2.00)	-0.023*** (-2.79)
<i>Post</i>	-0.009 (-0.84)	-0.009 (-0.82)	-0.009* (-1.84)	-0.008 (-1.43)
<i>Treatment * Post</i>	0.110*** (3.41)	0.106*** (3.33)	0.021** (2.16)	0.028*** (2.94)
<i>Ln (Assets)</i>	-0.003 (-0.53)	-0.008 (-1.02)	-0.001 (-0.44)	-0.002 (-0.45)
<i>Forecast Revision</i>	-0.013 (-1.43)	-0.014 (-1.38)	-0.007 (-1.61)	-0.007 (-1.41)
<i>Ln (# Patents)</i>		0.002 (0.52)		0.001 (0.35)
<i>Return Volatility</i>		-0.023 (-0.83)		-0.000 (-0.00)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	730	622	1,418	1,252
Adjusted R-Square	0.158	0.166	0.0903	0.092
Post Diff P-value	0.572	0.689	0.495	0.610

Panel B: Dependent Variable: EPS Bias

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	-0.008** (-2.06)	-0.012** (-2.53)	0.001 (0.97)	0.001 (0.93)
<i>Post</i>	0.002 (0.88)	0.001 (0.66)	0.000 (0.10)	0.000 (0.60)
<i>Treatment * Post</i>	0.002 (0.38)	0.003 (0.43)	-0.002 (-1.35)	-0.002 (-1.50)
<i>Ln (Assets)</i>	0.001 (0.98)	-0.001 (-0.71)	-0.000 (-0.55)	-0.000 (-0.63)
<i>Forecast Revision</i>	-0.002 (-1.56)	-0.003* (-1.99)	-0.001 (-1.58)	-0.001 (-1.49)
<i>Ln (# Patents)</i>		0.002*** (2.73)		0.001 (1.42)
<i>Return Volatility</i>		0.002 (0.14)		0.007* (1.85)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	799	719	1,224	1,119
Adjusted R-Square	0.193	0.221	0.071	0.100
Post Diff P-value	0.421	0.230	0.267	0.128

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test

**TABLE 3.7. SSO Committee Participation and Management Guidance Bias
(continued)**

Panel A (Panel B) presents results of OLS regressions with *Sales Bias* (*EPS Bias*)—the signed difference between actual sales (EPS) and management forecast of sales (EPS), scaled by sales (price)—as the dependent variable. *Treatment* = 1 for firms that contribute to SSO committees and *Treatment* = 0 for firms that do not. For each treatment (control) firm, we keep the three years prior to the treatment (placebo) year, where *Post*=0, and three years subsequent, where *Post*=1. *Treatment * Post* measures whether the change from before to after the treatment or placebo year is significantly different between treatment firms and control firms. *Forecast Revision* is an indicator variable that is equal to one for management forecasts that are a revision of a prior forecast and equal to zero for initial forecasts. Other variables are defined in Table 3. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients. Post Diff P-value is a *p*-value for the test $Treatment + Treatment * Post = 0$; i.e., whether the post-treatment level of the variable for treatment firms is significantly different than the pre-level for control firms.

TABLE 3.8. SSO Committee Participation and Management Guidance News*Panel A: Dependent Variable: Sales News*

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	-0.043** (-2.48)	-0.043** (-2.49)	-0.032*** (-3.02)	-0.036** (-2.39)
<i>Post</i>	-0.004 (-0.58)	-0.004 (-0.62)	-0.005 (-0.61)	-0.010 (-1.22)
<i>Treatment * Post</i>	0.038** (2.14)	0.042** (2.12)	0.031 (1.50)	0.038 (1.48)
<i>Ln (Assets)</i>	0.011** (2.35)	0.012* (1.95)	0.019** (2.16)	0.018* (1.79)
<i>Forecast Revision</i>	0.013 (1.43)	0.014 (1.37)	0.003 (0.30)	0.004 (0.30)
<i>Ln (# Patents)</i>		-0.003 (-1.57)		-0.007 (-1.08)
<i>Return Volatility</i>		-0.059** (-2.35)		-0.117* (-1.72)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	618	513	1,193	1,028
Adjusted R-Square	0.155	0.178	0.028	0.036
Post Diff P-value	0.736	0.919	0.959	0.919

Panel B: Dependent Variable: EPS News

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	-0.003** (-2.19)	-0.002 (-1.47)	-0.003* (-1.84)	-0.004 (-1.64)
<i>Post</i>	-0.000 (-0.69)	-0.000 (-0.49)	-0.000 (-0.43)	-0.001 (-0.60)
<i>Treatment * Post</i>	0.002 (1.40)	0.001 (0.89)	0.004* (1.96)	0.004 (1.46)
<i>Ln (Assets)</i>	0.001 (1.31)	0.001** (2.07)	0.002*** (3.09)	0.002** (2.12)
<i>Forecast Revision</i>	0.003*** (3.11)	0.004*** (3.36)	-0.001 (-0.46)	-0.001 (-0.62)
<i>Ln (# Patents)</i>		-0.001** (-2.43)		0.000 (0.35)
<i>Return Volatility</i>		0.002 (0.53)		-0.006 (-0.78)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	619	540	923	818
Adjusted R-Square	0.172	0.158	0.117	0.122
Post Diff P-value	0.307	0.609	0.370	0.946

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test

**TABLE 3.8. SSO Committee Participation and Management Guidance News
(continued)**

Panel A (Panel B) presents results of OLS regressions with *Sales News (EPS News)*—the signed difference between management forecast of sales (EPS) and the outstanding analyst consensus forecast of sales (price), scaled by sales (price)—as the dependent variable. *Treatment* = 1 for firms that contribute to SSO committees and *Treatment* = 0 for firms that do not. For each treatment (control) firm, we keep the three years prior to the treatment (placebo) year, where *Post*=0, and three years subsequent, where *Post*=1. *Treatment * Post* measures whether the change from before to after the treatment or placebo year is significantly different between treatment firms and control firms. *Forecast Revision* is an indicator variable that is equal to one for management forecasts that are a revision of a prior forecast and equal to zero for initial forecasts. Other variables are defined in Table 3. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients. Post Diff P-value is a *p*-value for the test $Treatment + Treatment * Post = 0$; i.e., whether the post-treatment level of the variable for treatment firms is significantly different than the pre-level for control firms.

TABLE 3.9. SSO Committee Participation and Analyst Forecast Dispersion*Panel A: Dependent Variable: Sales Dispersion*

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	-0.003 (-1.04)	-0.005 (-1.47)	-0.002 (-0.51)	-0.001 (-0.30)
<i>Post</i>	-0.004** (-2.12)	-0.003 (-1.59)	-0.002 (-1.09)	-0.001 (-0.52)
<i>Treatment * Post</i>	0.010 (1.57)	0.010 (1.66)	0.001 (0.16)	0.000 (-0.02)
<i>Ln (Assets)</i>	-0.001 (-1.22)	0.000 (-0.18)	-0.001 (-1.65)	-0.002* (-1.75)
<i>Ln (# Patents)</i>		0.000 (-0.03)		0.001 (0.97)
<i>Return Volatility</i>		0.020** (2.11)		0.011 (1.46)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	7,277	6,562	6,074	5,417
Adjusted R-Square	0.110	0.130	0.100	0.110
Post Diff P-value	0.255	0.330	0.662	0.652

Panel B: Dependent Variable: EPS Dispersion

	Annual Forecasts		Quarterly Forecasts	
	(1)	(2)	(3)	(4)
<i>Treatment</i>	0.001 (0.44)	0.000 (0.18)	0.000 (0.47)	0.000 (0.37)
<i>Post</i>	-0.000 (-0.23)	-0.000 (-0.10)	0.000 (0.03)	0.000 (0.00)
<i>Treatment * Post</i>	-0.004* (-1.77)	-0.004* (-1.86)	-0.001* (-1.77)	-0.001 (-1.62)
<i>Ln (Assets)</i>	-0.002*** (-2.72)	-0.000 (-0.24)	-0.001*** (-2.95)	-0.000 (-1.59)
<i>Ln (# Patents)</i>		-0.000 (-0.16)		0.000 (0.14)
<i>Return Volatility</i>		0.028* (1.76)		0.007* (1.77)
Industry and Year FE	Yes	Yes	Yes	Yes
Observations	8,522	7,815	7,392	6,735
Adjusted R-Square	0.082	0.118	0.107	0.124
Post Diff P-value	0.106	0.074	0.169	0.223

***, **, * Significantly different from zero at the 0.01, 0.05, 0.10 level, respectively, using a two-tailed test

TABLE 3.9. SSO Committee Participation and Analyst Forecast Dispersion (cont'd)

Panel A (Panel B) presents results of OLS regressions with *Sales Dispersion (EPS Dispersion)*—the firm-month standard deviation of analysts' forecasts of sales (EPS), scaled by sales (price)—as the dependent variable. *Treatment* = 1 for firms that contribute to SSO committees and *Treatment* = 0 for firms that do not. For each treatment (control) firm, we keep the three years prior to the treatment (placebo) year, where *Post*=0, and three years subsequent, where *Post*=1. *Treatment * Post* measures whether the change from before to after the treatment or placebo year is significantly different between treatment firms and control firms. Other variables are defined in Table 3. T-statistics are based on standard errors clustered by firm and appear in parentheses below the coefficients. Post Diff P-value is a *p*-value for the test *Treatment + Treatment * Post* = 0; i.e., whether the post-treatment level of the variable for treatment firms is significantly different than the pre-level for control firms.

APPENDICE

Appendix 1.A. Data definition

Audit characteristics

<i>Length of Auditable Periods</i>	The number of months required of the licensee to retain relevant documents for audit purposes.
<i>Unrestricted Audits</i>	An indicator variable equal to one if the contract specifies that the licensors are unrestricted to a certain number of audits per year, zero if there is some restriction.
<i>Audit Fee Penalties</i>	An indicator variable equal to one if the contract specifies that the licensors can charge the audit fee to the licensees upon detecting material errors, zero otherwise.
<i>Interest Penalties</i>	An indicator variable equal to one if the contract specifies that the licensor can impose on the licensees interest penalties for underpayments detected during an audit, zero otherwise.

Contract characteristics

<i>Royalty %</i>	Royalty rates.
<i>Material to Licensee</i>	An indicator variable equal to one if the contract meets the licensee's materiality threshold to file the contract with the SEC, zero otherwise.
<i>Exclusive License</i>	An indicator variable equal to one if the contract specifies that the licensor grants an exclusive license to the licensee, zero otherwise.
<i>Worldwide License</i>	An indicator variable equal to one if the contract specifies that the licensor grants a worldwide license to the licensee, zero otherwise.
<i>Licensor's Tech Support</i>	An indicator variable equal to one if the contract specifies that the licensee may request technical support from the licensor when necessary, zero otherwise.
<i>Duration until Patent Expiration</i>	An indicator variable equal to one if the contract duration is until expiration of patents, zero otherwise.
<i>Number of Deductible Items</i>	The number of deductible items allowed in royalty calculation.

Firm characteristics

<i>Licensee Size</i>	The licensee's total assets in the year prior to entering into the contract.
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<i>Licensee Volatility</i>	The standard deviation of the Licensee's EBITDA scaled by total assets over the five year period prior to entering into the contract.
<i>Non-Big N Financial Auditor</i>	An indicator variable equal to one if the firm's financial auditor is not one of the big N auditors in the year prior to entering the contract, zero otherwise.
<i>Industry Non-Specialist Financial Auditor</i>	Auditors are non-specialists if they audit less than 30 percentage of the market in the year prior to entering the contract.
<i>Same Industry</i>	An indicator variable equal to one if the Licensor and Licensees are in the same industry (Fama-French 12 Industry), zero otherwise.
<i>Product Market Fluidity</i>	A measure of firm-level competitive threats based on the description of firms' product space and rival moves in their 10-K's developed by Hoberg et al. (2014). The measure is available on http://hobergphillips.usc.edu/industryconcen.htm/ .
<i>Bargaining Power</i>	A discrete variable takes a value of zero if the licensor is a non-corporate entity or a privately-held company; one if the asset size difference between the licensor and licensee is below the median; and two if the asset size difference between the licensor and licensee is above the median.

Variables used in Appendix 1.C

<i>Assets - Total</i>	Total assets.
<i>Lev</i>	Long term debt plus short term debt, scaled by total assets.
<i>ROA</i>	Return on assets, measured as income before extraordinary items scaled by total assets.
<i>Fixed Assets</i>	Property, plant and equipment (net), scaled by total assets.
<i>R&D</i>	Research and development expenses.
<i>COGS/Sales</i>	Cost of goods sold, scaled by sales.
<i>Financial (Big N) Auditor Change_[t-i,t-1]</i>	An indicator variable that takes a value of one if the firm changed its (big N) financial auditors between <i>i</i> years and one year prior to entering the contract; zero otherwise.

Appendix 1.B. Example audit clauses

CONTRACT 1

(a) **AUDIT RIGHTS; PROCEDURE.** Upon the written request of LICENSOR, and not more than once in each calendar year, LICENSEE will permit an independent certified public accounting firm selected by LICENSOR, and reasonably acceptable to LICENSEE, at LICENSOR's expense, to have access during normal business hours, and upon reasonable prior written notice, to such of the records of LICENSEE as may be reasonably necessary to verify the accuracy of any financial reports to LICENSOR for any quarter within the preceding three (3) years.

(b) **ADDITIONAL PAYMENTS; COST REIMBURSEMENT.** If such accounting firm concludes that additional royalties or other payments were owed during such period, LICENSEE will pay the additional royalties or other payments, with interest from the date originally due at the prime rate, as published in The Wall Street Journal (Eastern U.S. Edition) on the last business day preceding such date, within thirty (30) days after the date Examiner delivers to Examinee such accounting firm's written report. If the amount of the underpayment is greater than five percent (5%) of the total amount owed, then LICENSEE will in addition reimburse LICENSOR for its reasonable costs related to such audit.

Length of auditable periods	36 months (3 years)
Unrestricted Audits	YES
Audit fee penalties	YES
Interest penalties	YES

Appendix 1.B. Example audit clauses (cont'd)

CONTRACT 2

A. Licensee shall keep, and shall require its Affiliates and use commercially reasonable efforts to require its Sublicensees to keep, full, true and accurate books and records...in sufficient detail to enable LICENSOR to determine Licensee's compliance with this Agreement. Said books and records, including books of account, shall be kept at Licensee's principal place of business or the principal place of business of the appropriate division of Licensee to which this Agreement relates. Said books and the supporting data shall be retained for at least six (6) years following the end of the calendar year to which they pertain.

B. In the event of a suspected breach by the Licensee of its payment obligations hereunder or its obligations pertaining to sublicenses, ... Licensor shall have the right to inspect, copy and audit, on fifteen (15) days prior written notice, at Licensor's expense, the books described above from time to time to verify the reports provided for herein or compliance in other respects with this Agreement. Any person(s) conducting such audit on behalf of Licensor shall be a Certified Public Accountant. ... Such accountant shall perform such inspection, copying and auditing at Licensor's expense during Licensee's regular business hours. Each party agrees to treat the results of any such accountant's review of the other party's records under this paragraph as Confidential Information.

Length of auditable periods	72 months (6 years)
Unrestricted Audits	NO
Audit fee penalties	NO
Interest penalties	NO

Appendix 1.C. Descriptive analysis on licensee firm characteristics

This table presents differences in mean values of firm characteristics for licensee firms compared to other firms. Panel A presents the difference in mean values for all the licensee firms ($N_1=975$) compared to all licensor firms with non-missing financial data ($N_2=441$). Panel B presents the difference in mean values for the licensee firms in the same industry as the licensor firms ($N_1=314$) compared to those in the *different* industries ($N_2=661$). Panel C presents the difference in mean values for the licensee firms ($N_1=975$) compared to other Compustat firms in the same industry-year with non-missing financial data ($N_2=15,096$). p -values (two-tailed) test for differences in means and appear in brackets.

Panel A. *Sample licensee firms versus licensor firms*

Variable	Licensee Firms		Licensor Firms		Diff. in means	p -value
	Mean	N	Mean	N		
Assets - Total(\$M)	2960.30	975	4681.06	441	-1720.76*	[0.02]
Lev	0.82	975	0.38	441	0.44**	[0.01]
ROA	-1.45	975	-0.79	441	-0.66**	[0.01]
Fixed Assets	0.16	971	0.15	439	0.01	[0.21]
R&D (\$M)	233.01	850	403.22	396	-170.21**	[0.01]
COGS/Sales	0.32	969	0.28	431	0.05**	[0.00]
Big N Auditor	0.71	975	0.68	441	0.03	[0.21]

Panel B. *Sample licensee firms in the same versus in different industries as licensor firms*

Variable	In Same Industries		In Diff. Industries		Diff. in means	p -value
	Mean	N	Mean	N		
Assets - Total(\$M)	6666.02	314	1199.94	661	5466.07***	[0.00]
Lev	0.33	314	1.06	661	-0.73**	[0.00]
ROA	-0.42	314	-1.94	661	1.52***	[0.00]
Fixed Assets	0.16	313	0.16	658	-0.01	[0.60]
R&D (\$M)	570.59	287	60.92	563	509.67***	[0.00]
COGS/Sales	0.28	311	0.35	658	-0.07***	[0.00]
Big N Auditor	0.84	314	0.65	661	0.19***	[0.00]

Panel C. *Sample licensee firms versus Compustat firms*

Variable	Licensee Firms		Compustat Firms		Diff. in means	p -value
	Mean	N	Mean	N		
Assets - Total(\$M)	2960.30	975	1427.77	15096	1532.53***	[0.00]
Lev	0.82	975	0.46	15096	0.36*	[0.02]
ROA	-1.45	975	-0.83	15096	-0.62*	[0.01]
Fixed Assets	0.16	971	0.14	15096	0.01**	[0.01]
R&D(\$M)	233.01	850	120.20	15096	112.81***	[0.00]
COGS/Sales	0.32	969	0.31	15096	0.01	[0.25]
Big N Auditor	0.71	975	0.67	15096	0.04**	[0.00]

Appendix 1.D. Penalty analysis using penalty index

This table presents results from penalty analysis using an index variable for penalties. The dependent variable, *Penalty Index*, takes the value of two if including both of the penalties, one if including either of the penalties, and zero if including no penalty terms; the variable is increasing in the stringency of the combined penalty terms. Panel A (B) reports the results using OLS (multinomial logit or probit) specifications. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All other variables are defined in Appendix 1.A.

Panel A. OLS

Variable	Pre-dicted	<i>Penalty Index</i>			
		(1) OLS	(2) OLS	(3) OLS	(4) OLS
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES					
<i>Non-Big N Financial Auditor</i>	-	0.0249 (0.0507)	0.0328 (0.0511)		
<i>Industry Non-Specialist Financial Auditor</i>	-			-0.197*** (0.0651)	-0.190*** (0.0655)
REPORTING FLEXIBILITY					
<i>No of Deductible Items</i>	+	0.144*** (0.0167)	0.148*** (0.0173)	0.143*** (0.0166)	0.147*** (0.0173)
SELF ENFORCE INCENTIVE					
<i>Worldwide License</i>	?	0.0482 (0.0498)	0.0479 (0.0496)	0.0573 (0.0500)	0.0580 (0.0498)
<i>Duration until Patent Expiration</i>	?	0.221*** (0.0529)	0.217*** (0.0538)	0.221*** (0.0525)	0.217*** (0.0535)
<i>Excl. License</i>	?	0.266*** (0.0924)	0.269*** (0.0928)	0.264*** (0.0942)	0.266*** (0.0948)
OTHER CONTRACT CHAR.					
<i>Licensor's Tech Support</i>		0.0596 (0.0500)	0.0651 (0.0505)	0.0621 (0.0499)	0.0667 (0.0503)
<i>Material to Licensee</i>		0.0495 (0.0658)	0.0478 (0.0665)	0.0745 (0.0666)	0.0732 (0.0672)
<i>Royalty %</i>		0.000690 (0.00163)	0.000584 (0.00161)	0.000716 (0.00163)	0.000580 (0.00163)
LICENSEE FIRM CHAR.					
<i>Licensee Size</i>		0.202 (0.251)	0.220 (0.246)	0.117 (0.246)	0.136 (0.242)
<i>Licensee Volatility</i>		0.00255*** (0.000426)	0.00230*** (0.000511)	0.00265*** (0.000393)	0.00242*** (0.000487)
<i>Licensee Product Market Fluidity</i>		0.0139** (0.00599)	0.0121* (0.00642)	0.0117* (0.00601)	0.0102 (0.00641)
<i>Same Industry</i>		0.0858 (0.0562)	0.0736 (0.0591)	0.0655 (0.0565)	0.0579 (0.0593)
Industry FE		NO	YES	NO	YES
Observations		975	975	975	975
R-squared		0.167	0.180	0.175	0.188

Panel B. Multinomial Logit/Probit

Variable	Pre- dict ed	Penalty Index					
		(1) M-Logit	(2) M-Logit	(3) M-Logit	(4) M-Logit	(5) Probit	(6) Probit
PERCEIVED ACCOUNTING SYSTEM WEAKNESSES							
<i>Non-Big N Financial Auditor</i>	-	0.113 (0.179)	0.108 (0.222)			0.0620 (0.101)	
<i>Industry Non-Specialist Financial Auditor</i>	-			-0.248 (0.229)	-0.766*** (0.257)		-0.280** (0.126)
REPORTING FLEXIBILITY							
<i>No of Deductible Items</i>	+	0.280*** (0.0583)	0.578*** (0.0751)	0.282*** (0.0585)	0.575*** (0.0753)	0.227*** (0.0324)	0.227*** (0.0325)
SELF ENFORCE INCENTIVE							
<i>Worldwide License</i>	?	0.0561 (0.168)	0.239 (0.215)	0.0699 (0.168)	0.273 (0.216)	0.0614 (0.0949)	0.0754 (0.0953)
<i>Duration until Patent Expiration</i>	?	0.576*** (0.175)	0.828*** (0.202)	0.570*** (0.175)	0.834*** (0.203)	0.399*** (0.0970)	0.398*** (0.0970)
<i>Excl. License</i>	?	1.605*** (0.369)	0.713* (0.379)	1.598*** (0.369)	0.734* (0.385)	0.736*** (0.171)	0.735*** (0.171)
OTHER CONTRACT CHAR.							
<i>Licensors Tech Support</i>		0.0521 (0.174)	0.227 (0.208)	0.0504 (0.173)	0.246 (0.208)	0.0671 (0.0967)	0.0665 (0.0966)
<i>Material to Licensee</i>		-0.0146 (0.215)	0.241 (0.260)	0.0249 (0.215)	0.345 (0.263)	0.0502 (0.121)	0.0875 (0.120)
<i>Royalty %</i>		-0.00540 (0.00570)	0.00407 (0.00660)	-0.00534 (0.00567)	0.00446 (0.00663)	-0.00109 (0.00313)	-0.00106 (0.00312)
LICENSEE FIRM CHAR.							
<i>Licensee Size</i>		1.273 (0.895)	0.720 (1.114)	1.061 (0.881)	0.339 (1.119)	0.679 (0.513)	0.520 (0.508)
<i>Licensee Volatility</i>		-3.34e-05 (0.00450)	0.00866* (0.00342)	0.000652 (0.00440)	0.00927* (0.00358)	0.00338* (0.00160)	0.00366* (0.00162)
<i>Licensee Product Market Fluidity Same Industry</i>		0.0313 (0.0204)	0.0558** (0.0245)	0.0296 (0.0205)	0.0474* (0.0248)	0.0233** (0.0113)	0.0208* (0.0114)
		-0.0765 (0.188)	0.356 (0.219)	-0.0997 (0.188)	0.272 (0.221)	0.0453 (0.105)	0.0194 (0.105)
Industry FE		NO	NO	NO	NO	NO	NO
Observations		975	975	975	975	975	975
Pseudo R-squared		0.0955	0.0955	0.0997	0.0997	0.111	0.115

Appendix 1.E. Internal control material weakness (ICMW) & AAER as proxies for perceived accounting system weaknesses

This table presents results from both audit scope and penalty analysis using ICMW and AAER as proxies for perceived accounting system weaknesses. The variable *ICMW* (*AAER*) takes a value of one if the licensee had ICMW (*AAER*) in the three years prior to entering into the contract, zero otherwise. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All other variables are defined in Appendix 1.A.

Variable	<i>Length of Auditable Periods</i>		<i>Unrestricted Audits</i>		<i>Audit Fee Penalties</i>		<i>Interest Penalties</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PERCEIVED ACCT SYS WEAKNESSES								
<i>ICMW</i>	-0.0275 (0.181)		0.0728 (0.0654)		0.00881 (0.0656)		0.0328 (0.0595)	
<i>AAER</i>		-0.371 (0.355)		0.0807 (0.0881)		0.150 (0.115)		-0.0524 (0.0959)
REPORTING FLEXIBILITY								
<i>No of Deductible Items</i>	-0.151*** (0.0382)	-0.176*** (0.0342)	-0.0557*** (0.0135)	-0.0571*** (0.0127)	0.0941*** (0.0133)	0.0861*** (0.0124)	0.0460*** (0.0126)	0.0518*** (0.0114)
SELF ENFORCE INCENTIVE								
<i>Worldwide License</i>	-0.288** (0.113)	-0.196* (0.105)	-0.0845** (0.0393)	-0.0879** (0.0382)	0.0675* (0.0409)	0.0531 (0.0388)	0.0128 (0.0375)	-0.000240 (0.0345)
<i>Duration until Patent Expiration</i>	-0.0123 (0.112)	-0.0443 (0.107)	-0.172*** (0.0402)	-0.170*** (0.0385)	0.189*** (0.0406)	0.145*** (0.0392)	0.0947** (0.0416)	0.111*** (0.0379)
<i>Excl. License</i>	0.125 (0.181)	0.219 (0.174)	-0.0414 (0.0641)	0.0508 (0.0611)	0.113 (0.0774)	0.180*** (0.0653)	0.0564 (0.0588)	0.0819 (0.0536)
Industry FE	NO	NO	NO	NO	NO	NO	NO	NO
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	703	737	703	737	703	737	703	737
R-squared	0.098	0.114	0.173	0.180	0.175	0.134	0.107	0.085

Appendix 1.F. Audit fees as a proxy for perceived accounting system weaknesses

This table presents results from both audit scope and penalty analysis using audit fees as a proxy for perceived accounting system weaknesses. Following Ettredge, Li and Scholz (2007), I estimate the expected audit fees (*Exp. Audit Fees*) and abnormal audit fees (*Positive Abn. Fees* and *Negative Abn Fees*) for subsample with available data. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All other variables are defined in Appendix 1.A.

Variable	<i>Length of Auditable Periods</i>		<i>Unrestricted Audits</i>		<i>Audit Fee Penalties</i>		<i>Interest Penalties</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PERCEIVED ACCT SYS WEAKNESSES								
<i>Positive Abn. Fees</i>	-0.421*	-0.417*	0.0406	0.0503	0.0674	0.0785	-0.0906	-0.0822
	(0.220)	(0.225)	(0.0866)	(0.0847)	(0.0852)	(0.0852)	(0.0737)	(0.0754)
<i>Negative Abn Fees</i>	0.210	0.289*	0.0705	0.0367	0.0235	0.00600	0.0916	0.0951
	(0.161)	(0.167)	(0.0725)	(0.0756)	(0.0651)	(0.0659)	(0.0581)	(0.0616)
<i>Exp. Audit Fees</i>	-0.159**	-0.174***	-0.0379	-0.0401*	0.0106	0.0131	-0.00412	-0.00604
	(0.0645)	(0.0653)	(0.0235)	(0.0238)	(0.0215)	(0.0211)	(0.0226)	(0.0239)
REPORTING FLEXIBILITY								
<i>No of Deductible Items</i>	-0.0951*	-0.102*	-0.0292	-0.0182	0.0974***	0.0908***	0.0165	0.0147
	(0.0514)	(0.0525)	(0.0191)	(0.0198)	(0.0185)	(0.0193)	(0.0175)	(0.0185)
SELF ENFORCE INCENTIVE								
<i>Worldwide License</i>	-0.218	-0.236	-0.126**	-0.119**	0.0485	0.0551	0.0619	0.0605
	(0.152)	(0.154)	(0.0564)	(0.0563)	(0.0559)	(0.0562)	(0.0517)	(0.0530)
<i>Duration until Patent Expiration</i>	-0.0441	-0.0498	-0.134**	-0.127**	0.207***	0.196***	0.142**	0.143**
	(0.151)	(0.154)	(0.0567)	(0.0566)	(0.0558)	(0.0565)	(0.0568)	(0.0571)
<i>Excl. License</i>	0.189	0.141	0.00551	0.0154	0.152*	0.142	0.0224	0.0150
	(0.292)	(0.271)	(0.0940)	(0.0959)	(0.0898)	(0.0898)	(0.0871)	(0.0892)
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Observations	385	385	385	385	385	385	385	385
R-squared	0.093	0.118	0.159	0.192	0.190	0.220	0.109	0.118

Appendix 1.G. Robustness tests on repeated licensor-licensee pairs

This table presents results from robustness analysis on repeated licensor-licensee pairs. Panel A reports results from the audit scope and penalty analysis after dropping the repeated licensor-licensee pairs (i.e., 42 observations). Panel B reports the results with the standard errors clustered by the licensor-licensee pairs. Standard errors are reported in parentheses, and ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. All other variables are defined in Appendix 1.A.

Variable	<i>Length of Auditable</i>		<i>Unrestricted Audits</i>		<i>Audit Fee Penalties</i>		<i>Interest Penalties</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PERCEIVED ACCT SYS WEAKNESSES								
<i>Non-Big N Financial Auditor</i>	0.151 (0.0985)		0.0690* (0.0366)		0.0427 (0.0351)		-0.0255 (0.0340)	
<i>Industry Non-Specialist Financial Auditor</i>		0.343*** (0.118)		0.0504 (0.0423)		-0.0528 (0.0427)		-0.0987** (0.0440)
REPORTING FLEXIBILITY								
<i>No of Deductible Items</i>	-0.166*** (0.0316)	-0.164*** (0.0316)	-0.0525*** (0.0121)	-0.0525*** (0.0121)	0.0990*** (0.0116)	0.0985*** (0.0116)	0.0490*** (0.0111)	0.0485*** (0.0111)
SELF ENFORCE INCENTIVE								
<i>Worldwide License</i>	-0.176* (0.0908)	-0.192** (0.0900)	-0.0513 (0.0339)	-0.0527 (0.0339)	0.0390 (0.0345)	0.0429 (0.0345)	-0.0120 (0.0314)	-0.00697 (0.0316)
<i>Duration until Patent Expiration</i>	-0.0260 (0.0967)	-0.0396 (0.0965)	-0.157*** (0.0349)	-0.161*** (0.0351)	0.144*** (0.0353)	0.143*** (0.0353)	0.0871** (0.0350)	0.0901** (0.0349)
<i>Excl. License</i>	0.0869 (0.145)	0.0945 (0.144)	0.00657 (0.0565)	0.00875 (0.0563)	0.206*** (0.0591)	0.206*** (0.0598)	0.0933* (0.0494)	0.0915* (0.0500)
OTHER CONTRACT CHAR.								
<i>Licensor's Tech Support</i>	-0.224** (0.0954)	-0.233** (0.0943)	-0.0478 (0.0345)	-0.0505 (0.0344)	-0.0126 (0.0349)	-0.0130 (0.0350)	0.0788** (0.0336)	0.0809** (0.0334)
<i>Material to Licensee</i>	-0.103 (0.121)	-0.117 (0.120)	0.0934** (0.0421)	0.0980** (0.0424)	-0.0211 (0.0433)	-0.00990 (0.0434)	0.0830** (0.0420)	0.0893** (0.0422)
<i>Royalty %</i>	-0.000690 (0.00302)	-0.000538 (0.00301)	0.00150 (0.00114)	0.00153 (0.00115)	-0.00156 (0.00107)	-0.00157 (0.00107)	0.00244** (0.00118)	0.00240** (0.00118)
LICENSEE FIRM CHAR.								
<i>Licensee Size</i>	-1.262** (0.594)	-1.222** (0.575)	-0.166 (0.184)	-0.182 (0.183)	-0.139 (0.174)	-0.176 (0.170)	0.292* (0.169)	0.272 (0.173)
<i>Licensee Volatility</i>	-0.00619*** (0.000775)	-0.00591*** (0.000783)	-0.00203*** (0.000355)	-0.00188*** (0.000333)	0.00115*** (0.000348)	0.00127*** (0.000349)	0.00120*** (0.000343)	0.00116*** (0.000337)
<i>Licensee Product Market Fluidity</i>	-0.0212* (0.0119)	-0.0184 (0.0119)	-0.0114*** (0.00432)	-0.0111** (0.00432)	0.00688 (0.00427)	0.00633 (0.00429)	0.00422 (0.00412)	0.00338 (0.00413)
<i>Same Industry</i>	-0.239** (0.112)	-0.223** (0.112)	-0.131*** (0.0399)	-0.132*** (0.0403)	0.0307 (0.0383)	0.0243 (0.0388)	0.0225 (0.0389)	0.0169 (0.0386)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	933	933	933	933	933	933	933	933
R-squared	0.114	0.119	0.172	0.169	0.166	0.166	0.099	0.104

Panel B.

Variable	<i>Length of Auditable</i>		<i>Unrestricted Audits</i>		<i>Audit Fee Penalties</i>		<i>Interest Penalties</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PERCEIVED ACCT SYS WEAKNESSES								
<i>Non-Big N Financial Auditor</i>	0.178*		0.0694*		0.0444		-0.0116	
	(0.0975)		(0.0356)		(0.0343)		(0.0339)	
<i>Industry Non-Specialist Financial Auditor</i>		0.309***		0.0531		-0.0763*		-0.113***
		(0.118)		(0.0412)		(0.0418)		(0.0436)
REPORTING FLEXIBILITY								
<i>No of Deductible Items</i>	-0.168***	-0.168***	-0.0573***	-0.0575***	0.101***	0.100***	0.0473***	0.0468***
	(0.0314)	(0.0314)	(0.0119)	(0.0118)	(0.0114)	(0.0113)	(0.0109)	(0.0110)
SELF ENFORCE INCENTIVE								
<i>Worldwide License</i>	-0.188**	-0.199**	-0.0605*	-0.0617*	0.0488	0.0535	-0.000902	0.00447
	(0.0892)	(0.0886)	(0.0332)	(0.0332)	(0.0340)	(0.0340)	(0.0310)	(0.0312)
<i>Duration until Patent Expiration</i>	-0.0330	-0.0471	-0.155***	-0.160***	0.142***	0.140***	0.0744**	0.0763**
	(0.0937)	(0.0936)	(0.0339)	(0.0340)	(0.0347)	(0.0346)	(0.0346)	(0.0345)
<i>Excl. License</i>	0.117	0.125	0.0191	0.0208	0.184***	0.183***	0.0847*	0.0826*
	(0.145)	(0.144)	(0.0541)	(0.0538)	(0.0573)	(0.0583)	(0.0483)	(0.0491)
OTHER CONTRACT CHAR.								
<i>Licensor's Tech Support</i>	-0.200**	-0.211**	-0.0545	-0.0576*	-0.0112	-0.0116	0.0763**	0.0783**
	(0.0940)	(0.0931)	(0.0336)	(0.0335)	(0.0344)	(0.0344)	(0.0334)	(0.0332)
<i>Material to Licensee</i>	-0.121	-0.129	0.0954**	0.0996**	-0.0387	-0.0239	0.0865**	0.0971**
	(0.119)	(0.118)	(0.0409)	(0.0412)	(0.0425)	(0.0425)	(0.0415)	(0.0418)
<i>Royalty %</i>	-0.00227	-0.00223	0.00133	0.00134	-0.00149	-0.00149	0.00208*	0.00207*
	(0.00298)	(0.00298)	(0.00109)	(0.00109)	(0.00103)	(0.00104)	(0.00113)	(0.00113)
LICENSEE FIRM CHAR.								
<i>Licensee Size</i>	-1.232**	-1.200**	-0.148	-0.161	-0.123	-0.171	0.344**	0.308*
	(0.584)	(0.570)	(0.179)	(0.178)	(0.174)	(0.168)	(0.168)	(0.172)
<i>Licensee Volatility</i>	-0.00619***	-0.00584***	-0.00201***	-0.00186***	0.00113***	0.00125***	0.00117***	0.00117***
	(0.000766)	(0.000787)	(0.000361)	(0.000339)	(0.000343)	(0.000347)	(0.000347)	(0.000333)
<i>Licensee Product Market Fluidity</i>	-0.0201*	-0.0172	-0.0115***	-0.0110***	0.00625	0.00547	0.00586	0.00474
	(0.0119)	(0.0119)	(0.00422)	(0.00422)	(0.00422)	(0.00423)	(0.00404)	(0.00404)
<i>Same Industry</i>	-0.187*	-0.173	-0.126***	-0.125***	0.0280	0.0201	0.0456	0.0378
	(0.110)	(0.109)	(0.0384)	(0.0388)	(0.0373)	(0.0379)	(0.0386)	(0.0383)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	975	975	975	975	975	975	975	975
R-squared	0.110	0.113	0.178	0.176	0.167	0.168	0.100	0.107

Appendix 2.A. Data definition

Country-level tax rates

<i>Licensor (Licensee) tax rates</i>	The highest statutory corporate tax rate in the country in the year prior to entering into the contract.
<i>Tax Difference</i>	The highest statutory corporate tax rate of the licensor minus that of the licensee in the year prior to entering into the contract.

State-level (US only) tax rates

<i>Licensor (Licensee) tax rates</i>	The highest state-level corporate tax rate in the US state in the year prior to entering into the contract. Data comes from Tax Foundation.
<i>Tax Difference</i>	The highest state-level corporate tax rate of the licensor minus that of the licensee in the year prior to entering into the contract.

Royalty rates

<i>Royalty Rate (%)</i>	Royalty rate of the license agreement.
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Other characteristics

<i>[Licensor] Log of Assets</i>	Logarithm of the licensor's total assets in the year prior to entering into the contract.
<i>[Licensee] Log of Assets</i>	Logarithm of the licensee's total assets in the year prior to entering into the contract.
<i>Worldwide License</i>	An indicator variable equal to one if the contract specifies that the licensor grants a worldwide license to the licensee, zero otherwise.
<i>Exclusive License</i>	An indicator variable equal to one if the contract specifies that the licensor grants an exclusive license to the licensee, zero otherwise.
<i>For-Profit Licensor</i>	An indicator variable equal to one if the licensor is a for-profit entity (i.e., company), zero otherwise.
<i>Price Setter</i>	An indicator variable equal to one if the contract is a pharmaceutical patent license, zero otherwise.

Appendix 3.A. Examples of Standard Setting Process and Working Committees

What are standards?

“Standards are published documents that establish specifications and procedures designed to maximize the reliability of the materials, products, methods, and/or services people use every day. Standards address a range of issues, including but not limited to various protocols to help maximize product functionality and compatibility, facilitate interoperability and support consumer safety and public health” (Source: Institute of Electrical and Electronics Engineers Standards Association [IEEE-SA] website).

How are standards made?

1. Initiating the Project
 - The development of a new standard is triggered by a formal request, submitted to an SSO by a Sponsoring Body (individual or entity) for review and evaluation.
2. Mobilizing the Working Group
 - Once the SSO approves the request, the sponsor follows the SSO rules to assemble a collaborative team or "Working Group" to engage in active standards development. Working Groups are comprised of individuals and/or entities (e.g., people, companies, organizations, non-profits, government agencies) who volunteer to support the development of the standard.
3. Drafting the Standard
 - Participants may contribute at varying levels to the standards development process, based on the rules and criteria established by the SSO. SSOs often have detailed rules to ensure that highly dedicated individuals lead participation and no one interest dominates the standards development process.
 - These activities fuel the gradual definition of each standard, which is compiled into a draft standard that may undergo multiple revisions.
4. Balloting the Standard
 - Once a draft standard has been finalized, reviewed, and approved by the Working Group, it is submitted to the Sponsor for Sponsor balloting. Upon successful completion of the Sponsor ballot, the draft is submitted to the Review Committee. The balloted draft is reviewed by Review Committee and then submitted to the Standards Board for approval.
5. Gaining Final Approval
 - After submission, review, and acceptance, the approved standard is published and made available for distribution and purchasing within in a number of outlets, including through the SSO itself.
6. Maintaining the Standard
 - It is important to remember that standards are “living documents”. Standards may initially be published and iteratively modified, corrected, adjusted and/or updated based on market conditions and other factors. (Source: IEEE-SA website).

Appendix 3.A (continued) Examples of Standard Setting Process and Working Committees

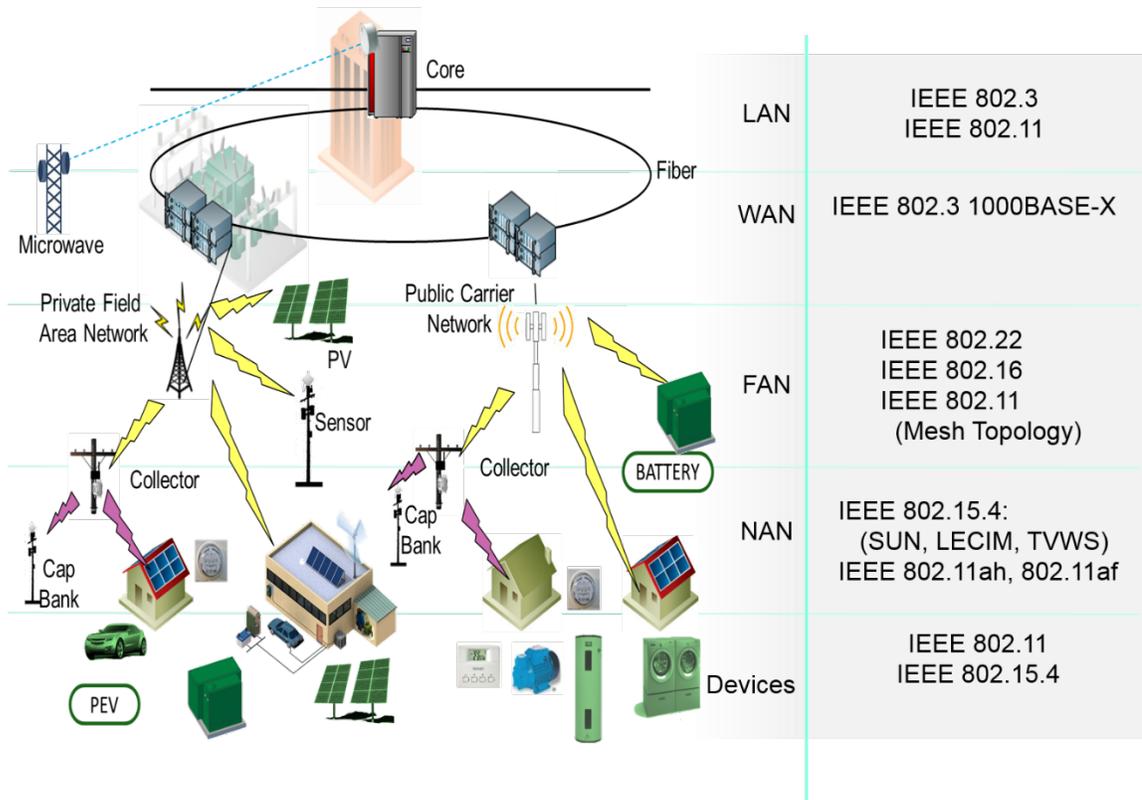
Example of Working Groups in an SSO

SSO: IEEE-SA (Institute of Electrical and Electronics Engineers Standards Association)

Standard: IEEE 802 LAN/MAN Standards (source: <http://www.ieee802.org/>)

- The IEEE 802 LAN/MAN Standards Committee develops and maintains networking standards and recommended practices for local, metropolitan, and other area networks, using an open and accredited process, and advocates them on a global basis. An individual Working Group provides the focus for each area.

Key Standards for Integrated Grid Communications Networks



Appendix 3.A (continued)
Examples of Standard Setting Process and Working Committees

IEEE 802 Working Groups:

- 802.3 Ethernet Working Group develops standards for Ethernet networks.
- 802.11 Wireless LAN Working Group develops standards on wireless local area networks (LAN).
- 802.15 Wireless Personal Area Network (WPAN) Working Group develops Personal Area Network standards for short distance wireless networks.
- 802.16 Broadband Wireless Access Working Group develops standards and recommended practices to support the development and deployment of broadband Wireless Metropolitan Area Networks.
- 802.21 Media Independent Handover Services Working Group is developing an extensible Media access Independent Services (MIS) framework (i.e., function and protocol) that enables the optimization of services including handover service when performed between heterogeneous IEEE 802 networks.
- 802.22 Wireless Regional Area Networks develops a wide variety of standards to enable spectrum sharing.

List of companies in Working Groups⁵¹

IEEE 802.11 (LAN & Devices)	IEEE 802.3 (Ethernet)	IEEE 802.11.22 (FAN)
AIRONET WIRELESS COMM	AT&T INC	AT&T INC
APPLE INC	BROADCOM CORP	BAE SYSTEMS PLC
AT&T INC	HP INC	INTEL CORP
KAPSCH TRAFFICOM AG	HYUNDAI CORP	MOTOROLA SOLUTIONS INC
AVAYA INC	INTEL CORP	NEXTWAVE WIRELESS INC
BLACKBERRY LTD	LINEAR TECHNOLOGY CORP	ORANGE SA
FUJITSU LTD	MOTOROLA SOLUTIONS INC	QUALCOMM INC
INTEL CORP	NORTEL NETWORKS CORP	STMICROELECTRONICS NV
INTERMEC INC	SEEQ TECHNOLOGY INC	TDF CORP
INTL BUSINESS MACHINES CORP	SYNOPTICS COMM INC	
JAPAN RADIO CO LTD	XEROX CORP	
KDDI CORP		
KONINKLIJKE KPN NV		
LUCENT TECHNOLOGIES INC		
MOTOROLA SOLUTIONS INC		
NIPPON TELEGRAPH & TELEPHONE		
NOKIA CORP		
NORAND CORP		
NOVELL INC		
PROXIM CORP		
RENEASAS ELECTRONICS CORP		
RSA SECURITY INC		
SHARP CORP		
SONY CORP		
STANDARD MICROSYSTEMS CORP		
SYMBOL TECHNOLOGIES		
TECHNICOLOR SA		
TOSHIBA CORP		
XIRCOM INC		

⁵¹ Not all of these companies have CRSP and Compustat data and, hence, not all of these firms are in our sample.

Appendix 3.B. Examples of Analyst and Firm Disclosures related to SSO Activity
Excerpts from Conference Calls

JULY 17, 2015 / 12:00PM, ERIC B.ST - Q2 2015 Ericsson Earnings Call

Kai Korschelt - BofA Merrill Lynch – Analyst:

“...And then my other question is on the 5G side. **Do you think you are in a good position to at least defend a good market share, in terms of standard essential patents, given that we are still only in the standard setting phase here?** Thank you.”

Hans Vestberg - Telefonaktiebolaget L M Ericsson – CEO

“I start backwards. I start with 5G. And I think we're in a good position. **We're early out, we're part of standardization. I think we have done a lot of innovation already.** We can basically replicate many of the discrete sort of requirements on 5G already, right now. We just need to put it in a little bit smaller phone. Right now, it's a little bit big.”

JULY 16, 2015 / 4:00PM, CSCO - Cisco Systems Inc Corporate Call - Goldman Sachs to Host Tech Talk With Cisco

Simona Jankowski - Goldman Sachs – Analyst

“So **how do you see all of those standard-setting bodies or consortia coexisting?** And will they actually solve the problem that they've set out to solve?”

Maciej Kranz - Cisco Systems Inc - VP, Corporate Technology Group

“...So the number of standards and standard-like bodies is in the hundreds. And so our approach -- and I think an industry approach -- has been, on the one hand, let's make sure that **we focus on a few of these standard bodies and consortia, and organizations, and focus them on specific problems...** So that we take all of these different implementations, and actually do proof of concepts, and make sure that multiple vendors can inter-operate in these environments.”

Appendix 3.B (continued)
Examples of Analyst and Firm Disclosures related to SSO Activity

Excerpts from Analyst Research Reports

Companies: Broadcom and Marvell

Publication Date: 5/14/2015

Contributor/Analyst: J.P. Morgan

Research report on Broadcom and Marvell (in the semiconductors sector)

“IEEE Patent Policy Update Could Impact the Connectivity Chipset Landscape in Favor of OW-rated BRCM and MRVL.

...

We focus on technology standard setting for the connectivity market (i.e., Wi-Fi, Ethernet) and believe that Broadcom and Marvell stand to benefit from this IEEE patent policy update as one of their major connectivity chipset competitors, Qualcomm, which charges royalties based on system (i.e., smartphone) ASP, plan to limit or remove itself from participation in the IEEE standards setting process. We believe Broadcom and Marvell, who are leaders in the connectivity chipset market and who we believe will adhere to the new patent policy update and continue to contribute intellectual property to the standardization of new Wi-Fi technologies in IEEE, will gain a 6-12 month time-to-market advantage in the connectivity chipset market. We reiterate our OW rating on BRCM and MRVL.”

Company: Silicon Storage Technology, Inc.

Publication Date: 7/17/2013

Contributor/Analyst: GLOBALDATA

“Silicon Storage Technology, Inc. - SWOT Analysis

Strength - Certificates and Professional Affiliations

SST is part of ETSI, the European Telecommunications Standards Institute, which manages the 3GPP Global Initiative. SST is dedicated to supporting global standards for telecommunications. SST is a member of the American Electronics Association (AeA), a nationwide non-profit trade association. It is an Affiliate Member of OMTP, an operator-sponsored forum that serves the needs of each and every link in the mobile phone value chain by gathering and driving mobile terminal requirements. In addition, the company received ISO 9001:2008 Quality Management System (QMS) certification in November 2010. This QMS certification compliments SST's established reputation for consistently delivering quality products and services that meet or exceed the company's customer's quality and regulatory requirements, while continually improving customer satisfaction and services. Such affiliation and certification further enhance the company's brand image and provide growth opportunities for the company.”

Appendix 3.B (continued)

Examples of Analyst and Firm Disclosures related to SSO Activity

Excerpts from 10-K/Qs

COMPANY: IXIA

FORM TYPE: 10-K

DOCUMENT DATE: December 31, 2014, FILING DATE: March 31, 2015, p. 12

Research and Development

We believe that research and development is critical to our business. Our development efforts include anticipating and addressing the network performance analysis and monitoring needs of network equipment manufacturers, service providers, enterprises and government customers, and focusing on emerging high growth network technologies.

Our future success depends on our ability to continue to enhance our existing products and to develop new products that address the needs of our customers. We closely monitor changing customer needs by communicating and working directly with our customers, partners and distributors. **We also receive input from our active participation in industry groups responsible for establishing technical standards.**

Development schedules for technology products are inherently difficult to predict, and there can be no assurance that we will introduce any proposed new products in a timely fashion. Also, we cannot be certain that our product development efforts will result in commercially successful products or that our products will not contain software errors or other performance problems or be rendered obsolete by changing technology or new product announcements by other companies.

COMPANY: SILICON IMAGE INC

FORM TYPE: 10-Q

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Our business may be adversely impacted as a result of the adoption of competing standards and technologies by the broader market.

The success of our business to date has depended on our participation in standard setting organizations, such as the HDMI and MHL Consortiums, and the widespread adoption and success of those standards. From time to time, competing standards have been established which negatively impact the success of existing standards or jeopardize the creation of new standards. DisplayPort is an example of a competing standard on a different technology base which has been created as an alternative high definition connectivity solution in the PC space. The DisplayPort standard has been adopted by many large PC manufacturers. While currently not as widely recognized as the HDMI standard, DisplayPort does represent a viable alternative to the HDMI or MHL technologies. If DisplayPort should gain broader adoption, especially with non-PC consumer electronics, our HDMI or MHL businesses could be negatively impacted and our revenues could be reduced. WiGig is an example of a competing 60GHz standard which has been created as an alternative high-bandwidth wireless connectivity solution for the PC industry. While the WiGig standard has not been in the market as long as the WirelessHD standard, it does represent a viable alternative to WirelessHD for 60GHz connectivity. If WiGig should gain broader adoption before WirelessHD is adopted, it could negatively impact the adoption of WirelessHD.

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